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BIOLOGICAL SCIENCES

ASSESSMENT OF METFORMIN LEVELS IN RAT LIVER TISSUE AFTER ADMINISTRATION BY DIFFERENT ROUTES

Obukhova D.,
2nd year postgraduate student at the N.P. Bekhtereva Institute of the Human Brain, Junior Researcher at the Laboratory of Neurochemistry, Institute of Experimental Medicine, St. Petersburg
Tarakanova O.,
3rd year Bachelor's degree student at Peter the Great Polytechnic University, St. Petersburg
Muruzheva Z.,
Candidate of Medical Sciences, researcher at the laboratory of Neurochemistry, Institute of Experimental Medicine, St. Petersburg
Karpenko M.
Doctor of Biological Sciences,
Head of the Laboratory of Neurochemistry Institute of Experimental Medicine, St. Petersburg
https://doi.org/10.5281/zenodo.18070619

Abstract

Metformin, a widely used antidiabetic drug, exhibits pleiotropic neuroprotective effects, but the role of hepatic accumulation in mediating these actions remains unclear. This study aimed to compare metformin concentrations in rat liver tissue following oral, intranasal, and intraperitoneal administration of 100 mg/kg/day over 7 and 14 days.

Adult male Wistar rats (n=8 per group) received metformin daily via the specified routes. Liver samples were analyzed using high-performance liquid chromatography with UV detection (HPLC-UV) after protein precipitation and extraction. Data were background-corrected due to limited method selectivity and analyzed via two-way ANOVA with Tukey's post-hoc test.

After 7 days, hepatic metformin levels were highest with oral administration (approximately 20 ng/mg tissue), intermediate with intraperitoneal (10 ng/mg), and lowest with intranasal (5 ng/mg). Prolonging treatment to 14 days significantly reduced concentrations across all routes ($p < 0.05$), with no inter-route differences (approximately 3 ng/mg tissue).

These findings indicate route-dependent initial hepatic uptake, with oral administration maximizing liver exposure short-term, and a general decline over time suggesting potential saturation or enhanced elimination. This provides a pharmacokinetic framework for future studies on metformin's CNS redistribution and neuroprotective potential, highlighting intranasal delivery as a means to bypass hepatic first-pass metabolism.

Keywords: Metformin, HPLC-UV, liver.

1. Introduction

Metformin is one of the most widely used drugs for the treatment of type 2 diabetes mellitus; however, in recent years it has attracted increasing interest as a compound with pronounced pleiotropic effects beyond its classical hypoglycemic action. Experimental and clinical studies have demonstrated the neuroprotective potential of metformin, including its anti-inflammatory, antioxidant [1], and mitochondria-protective effects [2], as well as its ability to modulate autophagy, energy metabolism, and AMPK-related signaling pathways. These effects make metformin a promising candidate for the prevention and treatment of neurodegenerative and cognitive disorders.

Despite intensive research into the neuroprotective properties of metformin, the mechanisms underlying its effects on the central nervous system remain a subject of debate. In particular, it is still unclear to what extent the systemic and peripheral effects of the drug—primarily at the liver level—may mediate its neurotropic action. The liver is a key target organ for metformin and a central regulator of energy and metabolic homeostasis, the disruption of which is closely linked to the development of neurodegenerative processes via the “liver–brain” axis.

The pharmacokinetic characteristics of metformin, including its active transport into hepatocytes via organic cation transporters and pronounced hepatic accumulation, determine both its metabolic and potential systemic effects [3]. At the same time, the route of administration can significantly influence the distribution of the drug between peripheral organs and the central nervous system, as well as the degree of hepatic uptake, which in turn may modulate the neuroprotective effects of metformin.

In recent years, there has been growing interest in alternative routes of metformin administration, including intranasal delivery, which is considered a potential method for targeting the drug to central nervous system structures while partially bypassing systemic circulation and first-pass hepatic metabolism. The intraperitoneal route, widely used in preclinical studies, provides rapid systemic distribution and can serve as a convenient model for comparative pharmacokinetic analyses. However, the impact of different administration routes on hepatic accumulation of metformin and its potential

role in mediating neuroprotective effects remains insufficiently studied.

In this context, the present study aims to comparatively investigate metformin accumulation in liver tissue following oral, intranasal, and intraperitoneal administration as an important step in the comprehensive evaluation of its pleiotropic and neuroprotective properties. The resulting data will help clarify the contribution of hepatic drug distribution to its systemic and central effects and provide a pharmacokinetic basis for further research on metformin as a neuroprotective agent.

2. Materials and methods

2.1. Animals

Adult male Wistar rats (body weight 320 ± 20 g) were used in the present study. The animals were obtained from the Federal State Unitary Enterprise "Laboratory Animal Nursery RAPPOLOVO" (Leningrad Region, Russian Federation). Rats were housed in standard laboratory cages (4–5 animals per cage) under controlled environmental conditions, including a temperature of 24 ± 1 °C, relative humidity of 45–65%, and a 12 h light/12 h dark cycle. Standard laboratory chow and tap water were provided *ad libitum* throughout the experimental period.

All experimental procedures were conducted in accordance with institutional animal care guidelines, the National Institutes of Health (NIH) Guide for the Care and Use of Laboratory Animals, and applicable national regulations (Ministry of Health of the Russian Federation Order No. 267, June 19, 2003; Guide for the Use of Laboratory Animals, Moscow, 2005). The study protocol was reviewed and approved by the Local Ethics Committee of the Federal State Budgetary Scientific Institution "Institute of Experimental Medicine".

2.2. Experimental design

The animals were randomly assigned to seven experimental groups, with eight rats in each group. Metformin was administered via different routes for either 7 or 14 consecutive days. Group 1 received metformin orally for 7 days, Group 2 received metformin intranasally for 7 days, and Group 3 received metformin intraperitoneally for 7 days. Group 4 received metformin orally for 14 days, Group 5 received metformin intranasally for 14 days, and Group 6 received metformin intraperitoneally for 14 days. Metformin was administered at a dose of 100 mg/kg. An additional control group consisted of intact animals that did not receive any treatment. At the end of the experiment, the rats were deeply anesthetized via intraperitoneal injection of Zoletil (15 mg/kg) and euthanized by decapitation using a guillotine (Open-Science AE1601, RPC Open-Science Ltd, Russia). All collected tissues were immediately frozen and stored at −80°C until further analysis.

2.3. High performance liquid chromatography for determination of metformin

Quantitative determination of metformin was performed using high-performance liquid chromatography (HPLC) with ultraviolet (UV) detection. Chromatographic separation was carried out on a reversed-phase analytical column Hypersil BDS C18 (250 × 4.6 mm) under isocratic conditions. The mobile phase consisted of 10 mM ammonium acetate, acetonitrile (15%, v/v), and octanesulfonic acid (3 mM), adjusted to pH 6.8. The mobile phase was freshly prepared, filtered through a 0.22 μm membrane filter, and degassed prior to use.

Elution was performed at a constant flow rate under ambient column temperature. The injection volume was set according to the analytical protocol. Metformin was detected using a UV detector at a wavelength of 233 nm. Chromatographic data acquisition and processing were carried out using the chromatography system software.

Quantification of metformin was based on peak area measurements using an external calibration curve constructed from reference standard solutions. The method demonstrated adequate selectivity, with no interfering peaks observed at the retention time of metformin, as well as acceptable linearity and reproducibility within the concentration range relevant to the study [4].

For the quantitative determination of metformin concentration in liver samples using HPLC-UV, a calibration curve was constructed using the external standard method (Fig.1). Initially, a series of standard solutions of metformin hydrochloride in the mobile phase were prepared across a concentration range of 0.1 to 50 μg/mL. Each standard solution was analyzed under the same chromatographic conditions as the experimental samples, and the peak area at the retention time corresponding to metformin was recorded. Based on the obtained data, a calibration curve was plotted as peak area versus concentration and fitted by linear regression. The concentration of metformin in each sample was automatically calculated from the regression equation based on the measured peak area.

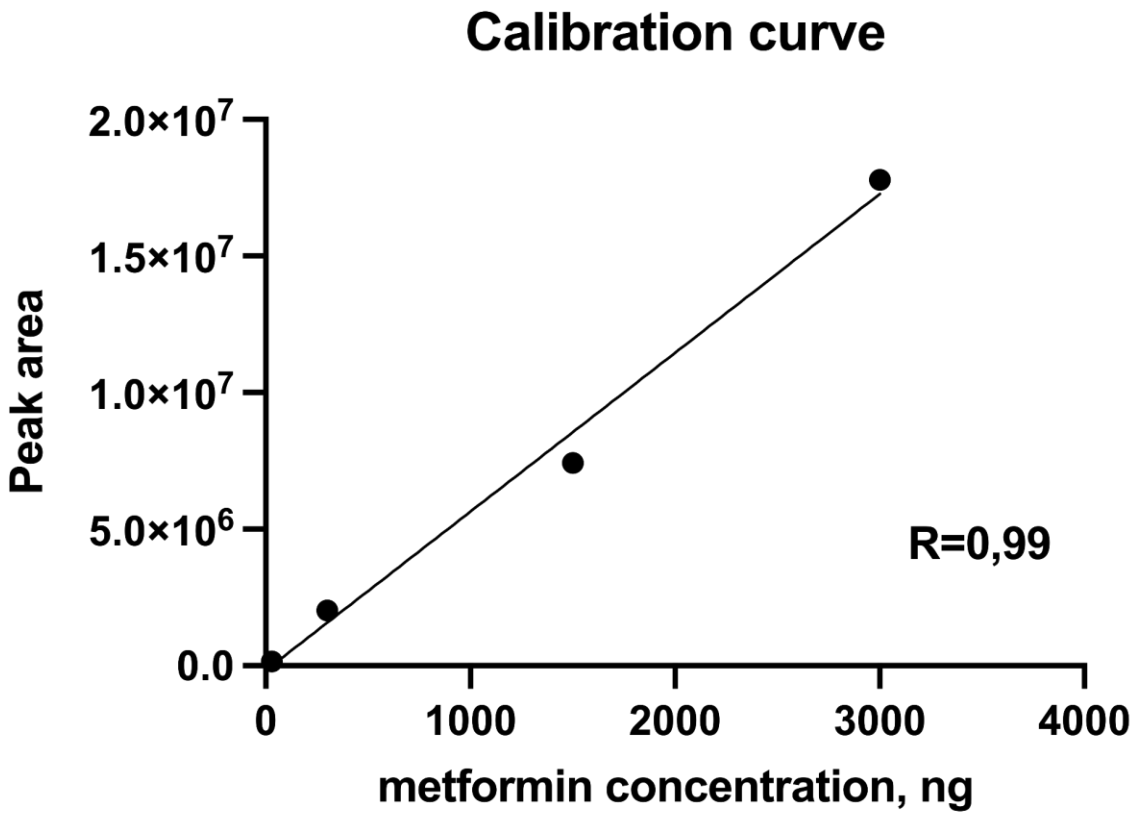

Fig. 1 *Calibration curve for metformin*

2.4.Sample preparation

Liver tissue samples were homogenized in a mixture of acetonitrile and methanol (5:4, v/v) to precipitate proteins and extract metformin. The resulting homogenates were centrifuged, and the supernatant was carefully collected. The supernatant was then evaporated to dryness by heating at 60 °C for 2 h.

The dried residue was reconstituted in the mobile phase, followed by centrifugation to remove any insoluble material. The final supernatant was transferred to autosampler vials and injected into the HPLC system for chromatographic analysis.

2.5.Statistical analysis

Statistical analysis was performed using GraphPad Prism 8.0.1 (GraphPad Software, USA). Normality of data distribution was assessed using the Shapiro-Wilk test. All data are presented as mean ± standard error of the mean (SEM) and individual data points. A two-way ANOVA was applied to evaluate the effects of two independent factors: (1) type of administration, and (2) time of administration. Post-hoc comparison procedures were conducted using Tukey's multiple comparison test. Statistical significance was set at $p < 0.05$ for all analyses.

3. Results

The HPLC–UV method used in the present study demonstrated limited selectivity for metformin. A detectable peak at the retention time corresponding to metformin was also observed in liver samples obtained from intact control animals. This background signal was quantified, averaged across control samples, and subsequently subtracted from the values obtained in metformin-treated groups. All data presented therefore represent background-corrected metformin concentrations in liver tissue.

Despite this methodological limitation, the corrected results consistently demonstrate that oral administration is associated with greater hepatic exposure to metformin during short-term treatment, whereas prolonged administration leads to a general decrease in detectable liver levels irrespective of the route of administration.

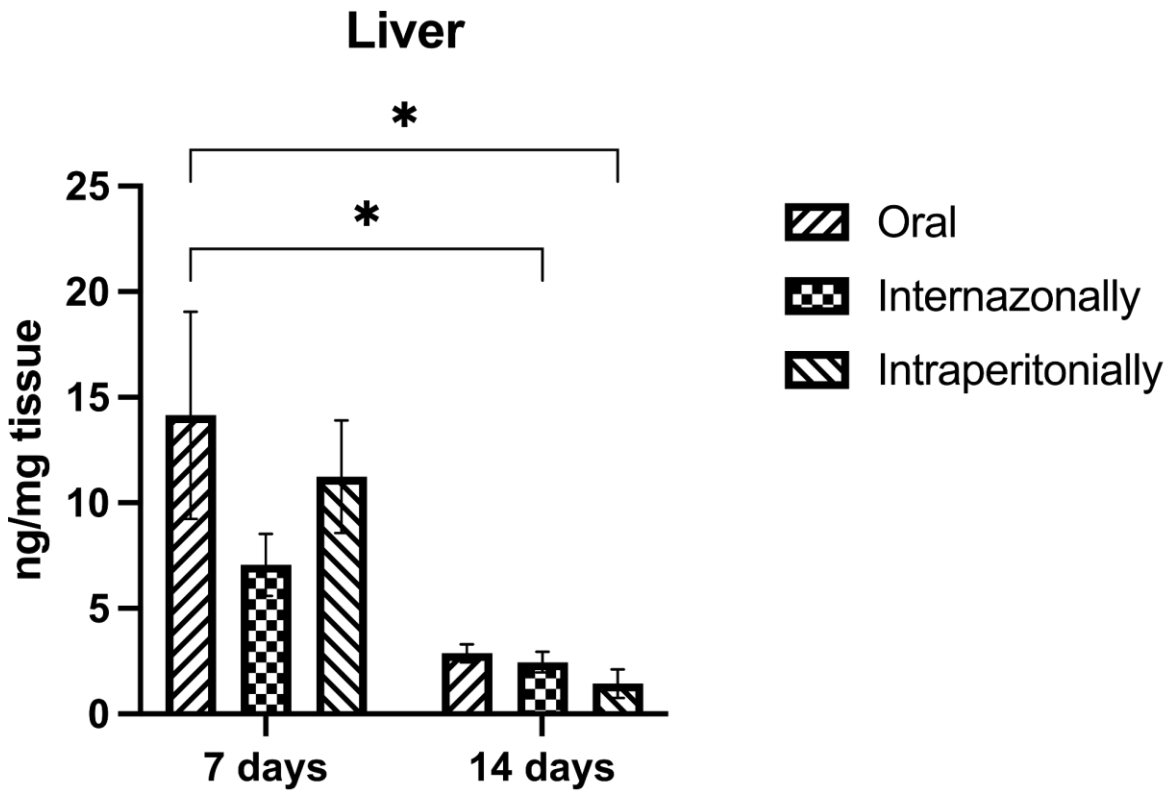

Fig. 2 *Metformin accumulation in liver tissue following oral, intranasal, and intraperitoneal administration for 7 and 14 days. Data are presented as mean ± SEM. Two-way analysis of variance (ANOVA) with Tukey's post-hoc test was used; * – $p < 0.05$.*

Analysis of metformin concentrations in liver tissue revealed significant differences depending on both the route and duration of administration. After 7 days of treatment, hepatic metformin levels were highest following oral administration, intermediate after intraperitoneal administration, and lowest after intranasal administration.

Extension of treatment duration to 14 days resulted in a significant reduction of metformin concentrations in the liver compared with the corresponding 7-day groups ($p < 0.05$). This decrease was observed irrespective of the route of administration. At 14 days, hepatic metformin levels were low and did not differ significantly between the oral, intranasal, and intraperitoneal groups.

Discussion

The present study provides a comparative analysis of metformin accumulation in rat liver tissue following oral, intranasal, and intraperitoneal administration over 7 and 14 days. These findings advance our understanding of how pharmacokinetic distribution between peripheral organs and the central nervous system (CNS) may influence metformin's pleiotropic neuroprotective effects.

The results clearly show that the route of administration markedly affects initial hepatic uptake. Highest liver concentrations after 7 days of oral dosing confirm the liver as a primary depot under standard administration, driven by extensive first-pass extraction and active uptake via organic cation transporters (OCT1) [5]. In contrast, intranasal delivery resulted in the lowest hepatic levels, consistent with partial bypassing of systemic circulation and first-pass metabolism, potentially favoring greater CNS availability [6], [7]. Intraperitoneal administration yielded intermediate accumulation, reflecting rapid systemic absorption without pronounced hepatic first-pass effects.

Most notably, hepatic metformin concentrations significantly decreased after 14 days across all routes. This time-dependent decline likely reflects adaptive processes, such as saturation of hepatic uptake mechanisms or enhanced elimination, allowing greater redistribution to extrahepatic tissues—including the brain—during prolonged treatment.

These dynamics have direct implications for metformin's neuroprotective potential. Early high hepatic exposure (especially oral) may prioritize peripheral metabolic actions, whereas reduced liver accumulation over time, or bypass via intranasal delivery, could enhance direct CNS effects (e.g., AMPK activation, anti-inflammatory actions). Intranasal administration thus emerges as a promising strategy to minimize hepatic sequestration and maximize brain targeting in neurodegenerative models.

Study limitations include the HPLC-UV method's limited selectivity (requiring background correction) and lack of concurrent brain or plasma measurements to confirm redistribution. Future studies should employ more sensitive techniques (e.g., LC-MS/MS) and directly assess CNS accumulation alongside cognitive outcomes to validate the hepatic bypass/redistribution hypothesis.

In summary, route- and duration-dependent hepatic pharmacokinetics provide a rational framework

for optimizing metformin regimens aimed at neuroprotection, with intranasal delivery offering particular promise for enhancing brain exposure.

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ECONOMIC SCIENCES

SOCIAL RESPONSIBILITY BUSINESS STRUCTURES AS A KEY FACTOR IN OPTIMIZING STRATEGIC MANAGEMENT OF REGIONAL DEVELOPMENT

Dyussembayev A.
Master's student,
Toraighyrov University, Pavlodar, Kazakhstan
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Abstract

The strategic management of regional development increasingly requires the integration of social factors alongside economic objectives. In this context, the social responsibility of business structures plays a significant role in ensuring sustainable and balanced regional growth. The purpose of this article is to examine social responsibility of business structures as a key factor in optimizing strategic management of regional development. The study analyzes theoretical approaches to strategic management and corporate social responsibility, identifies existing challenges in their integration at the regional level, and substantiates the need for closer cooperation between public authorities and business entities. The article proposes directions for incorporating social responsibility mechanisms into regional development strategies, aimed at improving socio-economic outcomes and enhancing regional competitiveness. The results of the study may be used in the development and adjustment of regional strategic planning documents.

Keywords: strategic management, regional development, social responsibility, business structures, sustainable development, corporate social responsibility

Introduction

In the context of globalization and ongoing socio-economic transformation, the effectiveness of strategic management of regional development has become a crucial factor in ensuring sustainable economic growth and social stability. Regions today face complex challenges related to economic restructuring, social inequality, and the need to improve the quality of life of the population. These challenges require new approaches to strategic management that go beyond traditional economic indicators and incorporate social dimensions of development.

Business structures play a significant role in regional development through investment activities, job creation, and innovation. However, the impact of business on regional socio-economic processes increasingly depends on the level of its social responsibility. Social responsibility of business structures contributes to addressing social issues, strengthening human capital, and promoting sustainable development at the regional level. As a result, the integration of social responsibility principles into regional development strategies becomes an important managerial task.

Despite the growing attention to corporate social responsibility in academic research, its role in optimizing strategic management of regional development remains insufficiently explored. In many regions, mechanisms for coordinating the interests of public authorities and business entities in the field of social responsibility are underdeveloped, which reduces the effectiveness of strategic planning and implementation.

The purpose of this article is to examine the social responsibility of business structures as a factor in optimizing strategic management of regional development. The objectives of the study include analyzing theoretical approaches to strategic management of regional development. The objectives of the study include analyzing theoretical approaches to strategic management and social responsibility, identifying key problems in their integration at the regional level, and proposing directions for incorporating social responsibility mechanisms into regional development strategies.

Research Methodology

This study is based on a combination of general scientific and specialized research methods aimed at analyzing the role of social responsibility of business structures in optimizing strategic management of regional development. The methodological framework integrates theoretical and analytical approaches to ensure the consistency and validity of the research findings.

Theoretical methods include the analysis, synthesis, and systematization of scientific literature on strategic management, regional development, and social responsibility of business structures. These methods are used to identify key concepts, theoretical approaches, and existing models that explain the interaction between business entities and regional development strategies.

Analytical methods are applied to examine the influence of social responsibility practices on regional socio-economic development. These include comparative analysis, structural analysis, and logical generalization, which allow for identifying relationships between strategic management mechanisms and social responsibility initiatives at the regional development.

The study also employs a system approach, considering regional development as a complex socio-economic system involving public authorities, business structures, and society. This approach makes it possible to assess the role of social responsibility as an integral element of strategic management rather than as an isolated business activity. In addition, the study uses an

institutional approach to analyze the regulatory and organizational environment that shapes socially responsible business behavior in regions. This approach helps to identify institutional constraints and opportunities for integrating social responsibility into regional strategic planning.

The research is based on secondary data sources, including official statistical data, analytical reports, policy documents, and academic publications. The results of the study are presented in the form of generalized conclusions and practical recommendations aimed at optimizing strategic management of regional development through enhanced social responsibility of business structures.

Theoretical background

Strategic management of regional development is traditionally understood as a system of long-term goals, priorities, and mechanisms aimed at ensuring sustainable socio-economic growth of a territory [3,4]. Modern management theory emphasizes that regional development strategies should not be limited to economic indicators but must also address social stability, human capital development, and environmental sustainability [1,2]. This approach reflects the shift from purely economic models of development to integrated and sustainable development concepts [1,8].

Business structures act as key participants in regional socio-economic systems. Through investment activities, employment generation, technological innovation, and fiscal contributions, businesses significantly influence regional development dynamics [5,6]. However, the effectiveness of this influence increasingly depends on the alignment of business activities with social interests and regional development priorities. This alignment is achieved through the implementation of social responsibility principles [1,2,7].

The concept of social responsibility of business structures is widely discussed in academic literature and international standards. According to ISO 26000, social responsibility refers to the responsibility of an organization for the impacts of its decisions and activities on society and the environment, through transparent and ethical behavior that contributes to sustainable development [1]. This definition emphasizes that social responsibility goes beyond voluntary philanthropy and becomes an integral part of strategic management [2,7].

Academic studies identify corporate social responsibility (CSR) as a multidimensional concept encompassing economic, social, and institutional components [8,9,10]. From a regional development perspective, CSR manifests in business participation in social infrastructure development, workforce training, environmental protection, and cooperation with local authorities [5,6,9]. Such activities contribute to improving quality of life, reducing social inequality, and strengthening regional competitiveness [10,11].

Theoretical approaches to regional development increasingly incorporate the systems and institutional perspectives [3,4]. The systems approach considers the region as a complex interaction of economic agents, public institutions, and social groups. Within this system, socially responsible business behavior enhances coordination between stakeholders and reduces conflicts between economic growth objectives and social needs [1,2]. The institutional approach focuses on formal and informal rules that regulate business behavior, including legal frameworks, strategic planning documents, and corporate governance standards [1,2,12].

Research on the relationship between social responsibility and regional development suggests that socially responsible business practices positively influence the effectiveness of strategic management [8,9]. By integrating CSR mechanisms into regional strategies, public authorities can mobilize additional resources, improve policy implementation, and increase public trust [5,6]. At the same time, businesses benefit from enhanced reputational capital, improved stakeholder relations, and more stable operating environments [8,10].

Despite the recognized importance of CSR, many regions face challenges related to its integration into strategic management systems. These challenges include insufficient coordination between government and business, lack of unified methodological approaches, and limited incentives for socially responsible behavior [10,11,12]. Therefore, theoretical justification of social responsibility as a factor in optimizing strategic management of regional development remains a relevant research task [1,2,8].

Thus, the theoretical basis of this study rests on the concepts of strategic regional management, sustainable development, and social responsibility of business structures. Their integration provides a conceptual framework for analyzing the role of socially responsible business behavior in enhancing the effectiveness of regional development strategies [12].

Findings and Discussion

The analysis of theoretical sources, official statistical data, and analytical reports confirms that the social responsibility of business structures has a significant impact on the effectiveness of strategic management of regional development. The results indicate that regions where socially responsible business practices are systematically integrated into development strategies demonstrate more balanced socio-economic outcomes, including improved employment indicators, higher quality of social infrastructure, and increased investment attractiveness.

Official statistical data and policy documents show that business structures actively participate in regional economies through investment projects, tax contributions, and employment creation. However, the extent to which these activities contribute to long-term regional development depends on whether they are aligned with social priorities defined in regional strategies. The findings suggest that in many regions, social responsibility initiatives remain fragmented and are not fully integrated into strategic planning processes.

The analysis of corporate reports of large businesses structures demonstrates that social responsibility activities are increasingly included in corporate strategies and sustainability reports. These activities typically focus on workforce development,

social infrastructure support, environmental protection, and community engagement. Such initiatives contribute to addressing local social problems and enhancing human capital, which is a critical factor of regional competitiveness. At the same time, the lack of coordination between corporate social responsibility programs and regional strategic objectives limits their overall effectiveness.

From a strategic management perspective, the results highlight that social responsibility can serve as an optimization factor by improving coordination between public authorities and business entities. The integration of CSR mechanisms into regional development strategies enables the mobilization of additional financial and organizational resources, reduces social tensions, and increases public trust in regional policies. This finding is consistent with institutional and systems approaches, which emphasize the importance of stakeholder interaction in complex socio-economic systems.

The discussion also reveals several key challenges that hinder the effective use of social responsibility in strategic regional management. These challenges include the absence of unified methodological approaches for assessing the contribution of CSR to regional development, insufficient incentives for socially responsible behavior, and weak institutional frameworks regulating public-private cooperation. As a result, CSR is often perceived as a voluntary or reputational activity rather than as a strategic management tool.

Despite these limitations, the results confirm that strengthening the role of social responsibility in strategic management can enhance the sustainability and resilience of regional development. The inclusion of socially responsible business practices in strategic planning documents, along with the development of institutional mechanisms for cooperation between government and business, creates conditions for achieving long-term socio-economic goals.

Overall, the findings support the hypothesis that social responsibility of business structures is not only in a complementary element but also a significant factor in optimizing strategic management of regional development. The discussion underscores the need for a systematic approach to integrating CSR into regional strategies, which would allow regions to achieve more sustainable and inclusive development outcomes.

Conclusion

The study demonstrates that the social responsibility of business structures plays a significant role in optimizing strategic management of regional development. The findings confirm that the integration of social responsibility principles into regional development strategies enhances coordination between public authorities and business entities, contributes to more balanced socio-economic outcomes, and supports sustainable regional growth. Despite existing institutional and methodological challenges, social responsibility should be considered not only as a voluntary business initiative but as an essential element of effective strategic regional management. Strengthening mechanisms for integrating socially responsible business practices into strategic planning can improve the long-term sustainability and competitiveness of regional development.

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MODEL OF TRANSFORMATIONAL LEADERSHIP SKILLS BASED ON THE EXAMPLE OF THE CITY CLINICAL HOSPITAL IN ALMATY

Tolegenova S.,
Doctoral student of Business Administration,
Al-Farabi Kazakh National University (Almaty, Kazakhstan)
Maukenova A.
Cand. Sc. (Econ.), Associate Professor,
S.D. Asfendiyarov Kazakh National Medical University,
Almaty, Kazakhstan,
ORCID ID: https://orcid.org/0000-0001-7725-2845.

МОДЕЛЬ НАВЫКОВ ТРАНСФОРМАЦИОННОГО ЛИДЕРСТВА НА ПРИМЕРЕ ГОРОДСКОЙ КЛИНИЧЕСКОЙ БОЛЬНИЦЫ г.АЛМАТЫ

Толегенова С.
Докторант DBA
КазНУ им.аль-Фараби,
г. Алматы, Республика Казахстан
ORCID ID: https://orcid.org/0009-0005-6987-6638
Маукенова А.
к.э.н., ассоц. профессор КазНМУ им.С.Д.Асфендиярова,
г. Алматы, Республика Казахстан,
ORCID ID: https://orcid.org/0000-0001-7725-2845
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Abstract

The aim of this study is to develop an integrative model of transformational leadership skills in healthcare based on an empirical analysis of differences between doctors and nurses in their perceptions of leadership, innovation and teamwork. The study showed that the success of innovation and organisational change is determined by a combination of soft and hard leadership skills. The developed model demonstrates how transformational leadership contributes to the development of an innovative culture, interdisciplinary cooperation, and improved quality of medical care. The results obtained are of practical importance for the management of healthcare organisations and the development of professional development programmes for leaders.

Аннотация

Целью данного исследования является разработка интегративной модели навыков трансформационного лидерства в здравоохранении на основе эмпирического анализа различий между врачами и медсестрами в их восприятии лидерства, инновационной деятельности и командной работы. Исследование показало, что успех инноваций и организационных изменений определяется сочетанием мягких и жестких навыков лидеров. Разработанная модель демонстрирует, как трансформационное лидерство способствует развитию инновационной культуры, междисциплинарного сотрудничества и повышению качества медицинской помощи. Полученные результаты имеют практическое значение для управления организациями здравоохранения и разработки программ профессионального развития для лидеров.

Keywords: transformational leadership, healthcare, innovation, soft skills, hard skills, healthcare organisations.

Ключевые слова: трансформационное лидерство, здравоохранение, инновации, мягкие навыки, жесткие навыки, организации здравоохранения.

Введение: В условиях ускоряющихся изменений в системе здравоохранения, цифровизации медицинских услуг и растущих требований к качеству и безопасности медицинской помощи роль лидерства в организациях здравоохранения приобретает особое значение [1]. Недавние исследования показывают, что наличие одних только ресурсов и технологий не гарантирует успешного внедрения инноваций; ключевым фактором является управленческое поведение лидеров и их способность вовлекать персонал в процессы изменений [2].

Трансформационное лидерство характеризуется способностью повышать ценности, мотивацию и стремления последователей, согласовывая индивидуальные цели с общими, более высокими организационными задачами. В контексте здравоохранения этот стиль лидерства особенно важен для управления сложными организационными изменениями, поскольку он делает акцент на коллективной цели, а не на индивидуальной выгоде [3], [4]. Такие области, как безопасность пациентов, качество медицинской помощи и благополучие персонала, требуют от лидеров активного вовлечения медицинских работников в содержательный диалог об общих целях, развития приверженности и культивирования культуры ответственности и доверия.

Продвигая общие ценности и долгосрочное видение, трансформационные лидеры помогают снизить сопротивление изменениям и укрепить организационную сплоченность [5].

В отличие от транзакционного лидерства, которое в основном опирается на внешние вознаграждения, мониторинг результатов и корректирующие действия, трансформационное лидерство поощряет сотрудничество и внутреннюю мотивацию. Этот подход особенно актуален в учреждениях здравоохранения, где профессиональная автономия, этическая ответственность и командная работа имеют центральное значение для эффективного предоставления услуг. Трансформационные лидеры направляют сотрудников посредством последовательной коммуникации, непрерывных возможностей обучения и четкого определения целей, тем самым укрепляя приверженность организационным приоритетам, таким как безопасность пациентов, клиническое совершенство и инновации. В условиях все более динамичной и неопределенной среды, обусловленной цифровой трансформацией, нехваткой рабочей силы и долгосрочными последствиями пандемии COVID-19, инновации стали неотъемлемой частью устойчивости и роста организации [6]. Исследования неизменно подчеркивают роль лидерства, особенно трансформационного лидерства, как ключевого фактора креативности и инновационного поведения сотрудников.

Инновационное поведение включает в себя как генерацию, так и внедрение новых идей и в значительной степени носит дискреционный характер, поскольку часто выходит за рамки формальных должностных обязанностей и может не вознаграждаться напрямую [7]. Трансформационное лидерство поддерживает такое поведение, создавая психологически безопасную и благоприятную рабочую среду, где поощряются эксперименты, а неудачи рассматриваются как часть процесса обучения. Укрепляя внутреннюю мотивацию и усиливая общее чувство цели, трансформационные лидеры позволяют медицинским работникам более полно участвовать в инновациях, в конечном итоге способствуя повышению эффективности организации и качества медицинской помощи. Несмотря на растущий интерес к трансформационному лидерству, в научной литературе по-прежнему недостаточно эмпирически обоснованных моделей, учитывающих различия между профессиональными группами медицинского персонала. Поэтому разработка модели лидерских навыков на основе данных из реальной практики врачей и медсестер является актуальной задачей.

Цель данной статьи — разработка модели трансформационных лидерских навыков в здравоохранении на основе эмпирических данных о лидерском поведении, инновационной деятельности и практике командной работы медицинского персонала.

Материалы и методы: Данное исследование основано на вторичном анализе эмпирических данных, полученных в ходе анкетирования врачей и медсестер, работающих в медицинских организациях. Эти данные были собраны, проанализированы и опубликованы авторами на предыдущем этапе исследования. Первичный сбор данных для данного исследования не повторялся; исследование носит аналитический и концептуальный характер.

В рамках вторичного анализа изучались различия между врачами и медсестрами в их восприятии управленческого лидерского поведения, уровня инновационной активности, участия в командной работе и рефлексивной практике, а также готовности к внедрению новых медицинских технологий. Для анализа использовались описательные и сравнительные статистические методы, результаты которых послужили эмпирической основой для интерпретации лидерских и организационных процессов в медицинских организациях.

Модель трансформационного лидерства была разработана с использованием аналитического и индуктивного подходов. Эмпирические результаты были концептуально обобщены, систематизированы и сгруппированы в логически взаимосвязанные блоки, отражающие поведенческие (мягкие навыки) и управленческие (жесткие навыки) компетенции руководителей медицинских организаций.

Для оценки достоверности, практической применимости и воспринимаемой ценности разработанной модели было проведено качественное исследование в фокус-группах. В обсуждении приняли участие двенадцать экспертов, включая руководителей медицинских организаций (n = 5), врачей (n = 3), представителей медперсонала (n = 3) и эксперта по качеству медицинской помощи (n = 1).

Обсуждение в фокус-группах проходило по полуструктурированному сценарию и было направлено на оценку степени согласия с предложенной моделью, ее соответствия реальной управленческой и профессиональной практике, выявление потенциальных барьеров для внедрения и определение практической ценности модели для управления медицинскими организациями. Обсуждение было записано, после чего был проведен качественный тематический анализ полученных утверждений с последующей их группировкой по ключевым семантическим категориям.

Результаты и дискуссия:

Концептуальная основа и описание модели трансформационного лидерства. Модель включает три взаимосвязанных, эмпирически обоснованных блока (рисунок 1).

Первый блок отражает лидерское поведение руководителей медицинских организаций и включает элементы как трансформационного, так и транзакционного лидерства. Этот блок охватывает такие аспекты, как стратегическое видение, мотивация персонала, индивидуальный подход, управление эффективностью и соблюдение стандартов.

Второй блок фокусируется на инновационной деятельности медицинского персонала и включает в себя генерацию новых идей, участие во внедрении медицинских технологий, готовность к изменениям и проактивное профессиональное поведение. Эмпирические данные показали, что инновационная деятельность проявляется по-разному у врачей

и медсестер, что требует дифференцированного подхода к лидерству.

Третий блок включает в себя командные и рефлексивные практики, в том числе открытый профессиональный диалог, критическое обсуждение, обмен знаниями и межпрофессиональное сотрудничество. Именно благодаря этим практикам лидерское поведение трансформируется в коллективное обучение, совершенствование процессов и повышение качества медицинской помощи.

Интеграция этих блоков позволяет рассматривать лидера-трансформатора в организации здравоохранения как центрального агента перемен, который, благодаря сочетанию поведенческих и управленческих навыков, создает условия для мотивации персонала, профессионального развития, формирования инновационной культуры и устойчивого междисциплинарного сотрудничества.

3. Структура модели навыков трансформационного лидерства

3.1. Мягкие навыки как основа трансформационного лидерства

Первый уровень модели представлен мягкими навыками, которые включают поведенческие и социальные компетенции лидера. Результаты исследования показывают, что именно эти навыки в наибольшей степени определяют готовность медицинского персонала к изменениям и внедрению инноваций.

Вдохновляющее лидерство и стратегическое видение проявляются в способности лидера создавать убедительное видение будущего и объединять персонал вокруг общей миссии. Врачи значительно чаще воспринимают лидеров как визионеров, что связано с их большей готовностью к организационным изменениям, использованием доказательной медицины и участием в рефлексивной командной практике.

Рисунок 1. Интегративная модель навыков трансформационного лидерства в медицинской организации

Эмоциональный интеллект и индивидуальный подход особенно важны для медицинского персонала. Медсестры выше оценивают поддерживающее и мотивирующее поведение лидеров, что коррелирует с их большей инновационной активностью, вовлеченностью и готовностью брать на себя расширенные профессиональные обязанности.

Коммуникация и межпрофессиональное сотрудничество необходимы для эффективной командной работы. Врачи чаще участвуют в профессиональных дискуссиях и рефлексивных практиках, в то время как медсестры реже отмечают наличие структурированных пространств для диалога, что подчеркивает роль лидерства в создании психологически безопасной среды и содействии междисциплинарному сотрудничеству.

Поддержка инноваций и творчества помогает реализовать инновационный потенциал медицинского персонала, особенно медсестер, которые чаще сообщают о генерации новых идей и участии

в внедрении инноваций при поддержке руководства.

3.2. Профессиональные навыки как инструмент трансформационного лидерства

Второй уровень модели включает профессиональные (жесткие) навыки, которые позволяют практически реализовать лидерский потенциал.

Управление изменениями и внедрение технологий являются ключевыми компетенциями, поскольку основными барьерами для инноваций остаются трудности в интеграции технологий, недостаток обучения и ресурсов.

Аналитические и цифровые компетенции особенно выражены среди врачей, которые чаще используют медицинские базы данных и принципы доказательной медицины, в то время как медсестрам требуется целенаправленное развитие этих навыков.

Управление обучением и развитием (НПР) играет решающую роль в успешном внедрении инноваций. Низкий уровень участия в программах обучения, особенно среди медсестер, подчеркивает необходимость системного наставничества и программ профессионального развития.

Этическое и нормативное управление способствует укреплению доверия к управленческим решениям и устойчивости организации здравоохранения, особенно в контексте внедрения новых медицинских технологий.

4. Интегративная логика модели

Интегративная логика модели заключается в том, что трансформационный лидер, опираясь на развитые «мягкие навыки», создает мотивирующую и психологически безопасную рабочую среду. Это создает условия для эффективного применения профессиональных навыков, развития командной рефлексии и междисциплинарного сотрудничества, что в конечном итоге приводит к инновациям, повышению качества медицинской помощи и устойчивости организации здравоохранения.

Практическая ценность модели и результаты обсуждения в фокус-группе

Результаты обсуждения в фокус-группе продемонстрировали высокий уровень согласия участников с предложенной моделью навыков трансформационного лидерства в здравоохранении. Большинство респондентов отметили, что модель адекватно отражает реальные управленческие процессы, различия в профессиональных ролях врачей и медсестер, а также ключевые факторы, влияющие на внедрение инноваций в организациях здравоохранения.

Руководители медицинских организаций подчеркнули, что модель логически структурирует требования к современному лидеру и позволяет четко понимать взаимосвязь между лидерским поведением, развитием персонала и результатами деятельности организации. Они считают, что разделение навыков на «мягкие» и «жесткие» навыки имеет практическое значение и может использоваться при оценке управленческих компетенций и формировании кадрового резерва.

Врачи отметили, что модель адекватно отражает их аналитическую, рефлексивную и основанную на доказательствах роль в деятельности здравоохранения и подчеркивает важность стратегического видения и этического лидерства. В частности, было отмечено, что наличие четкого лидерского видения снижает сопротивление изменениям и повышает доверие к управленческим решениям.

Представители медицинского персонала согласились с тем, что модель учитывает их вклад в инновации на операционном уровне. Они подчеркнули важность поддержки инициативы, эмоционального интеллекта руководителей и доступа к обучению как ключевых условий для повышения вовлеченности пациентов и качества медицинской помощи.

Участники фокус-группы назвали ограниченное время у руководителей, недостаток ресурсов для обучения персонала и сохраняющиеся иерархические барьеры между профессиональными группами в качестве основных препятствий для внедрения модели. Однако большинство участников отметили, что предложенная модель может служить инструментом для выявления этих барьеров и основой для целенаправленных управленческих вмешательств.

Также была подчеркнута практическая ценность модели как основы для разработки программ обучения и непрерывного профессионального развития руководителей, а также для содействия культуре междисциплинарного сотрудничества и инноваций в организации здравоохранения.

Выводы: Трансформационное лидерство в здравоохранении представляет собой набор специфических мягких и жестких навыков, определяющих успешное внедрение инноваций, развитие медицинских команд и устойчивость организаций здравоохранения. Разработанная модель отражает различия в профессиональных ролях врачей и медсестер и подчеркивает необходимость дифференцированного и инклюзивного подхода к лидерству. Для органов здравоохранения и руководителей организаций здравоохранения результаты исследования подчеркивают необходимость интеграции модели навыков трансформационного лидерства в программы обучения и оценки управленческих навыков. Политика развития человеческих ресурсов должна фокусироваться не только на административных компетенциях, но и на развитии эмоционального интеллекта, межпрофессиональной коммуникации, управления изменениями и цифровых навыков. Включение этих компетенций в системы сертификации и непрерывного профессионального развития может повысить эффективность внедрения медицинских технологий и качество здравоохранения.

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APPLICATION OF GRADIENT BOOSTING AND RANDOM FOREST METHODS FOR ESG ESTIMATION-CRITERIA FOR ISSUING BANK LOANS

Korchinsky A.
Postgraduate student of the Faculty of Economics
Belarusian State University
Minsk, Republic of Belarus

ПРИМЕНЕНИЕ МЕТОДОВ ГРАДИЕНТНОГО БУСТИНГА И СЛУЧАЙНОГО ЛЕСА ДЛЯ ОЦЕНКИ ESG-КРИТЕРИЕВ ПРИ ВЫДАЧЕ БАНКОВСКИХ КРЕДИТОВ

Корчинский А.С.
аспирант экономического факультета
Белорусский государственный университет
г. Минск, Республика Беларусь
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Abstract

With the growing importance of sustainable development and the introduction of ESG criteria into financial practice, banks are faced with the need to integrate new approaches to assessing borrowers' creditworthiness. The article discusses the use of machine learning methods — gradient boosting and random forest — to analyze companies' ESG indicators when making loan decisions. The proposed approach makes it possible to take into account not only traditional financial metrics, but also environmental, social and managerial factors, which increases the accuracy of risk forecasting and contributes to the formation of a more responsible credit policy. The results of the study demonstrate the potential of using ensemble algorithms to build interpretable models capable of identifying key ESG determinants that affect the probability of default and the stability of the borrower.

Аннотация

В условиях роста значимости устойчивого развития и внедрения ESG-критериев в финансовую практику банки сталкиваются с необходимостью интеграции новых подходов к оценке кредитоспособности заемщиков. В статье рассматривается применение методов машинного обучения — градиентного бустинга и случайного леса — для анализа ESG-показателей компаний при принятии решений о выдаче кредитов. Предлагаемый подход позволяет учитывать не только традиционные финансовые метрики, но и экологические, социальные и управленческие факторы, что повышает точность прогнозирования рисков и способствует формированию более ответственной кредитной политики. Результаты исследования демонстрируют потенциал использования ансамблевых алгоритмов для построения интерпретируемых моделей, способных выявлять ключевые ESG-детерминанты, влияющие на вероятность дефолта и устойчивость заемщика.

Keywords: ESG; loans; banks; sustainable financing; financial metrics; risk; gradient boosting; random forest; interpretability of models; sustainable development.

Ключевые слова: ESG; кредиты; банки; устойчивое финансирование; финансовые метрики; риск; градиентный бустинг; случайный лес; интерпретируемость моделей; устойчивое развитие.

Понятие ESG возникло в начале 2000-х годов, когда Организация Объединённых Наций инициировала программу «Принципы ответственного инвестирования» (PRI). В 2004 году в докладе «Who Cares Wins» впервые было предложено систематически учитывать экологические, социальные и управленческие факторы при принятии инвестиционных решений. С этого момента ESG стало международным стандартом устойчивого финансирования, а банки начали интегрировать его в практику кредитования.

Методы машинного обучения, используемые для анализа ESG-данных, появились немного раньше. Алгоритм градиентного бустинга был предложен Джеромом Фридманом в 1999 году в Стэнфорде как развитие идей AdaBoost. Он рассматривает построение ансамбля моделей как задачу оптимизации функции потерь и позволяет достигать высокой точности прогнозов. Алгоритм случайного леса разработал Лео Брейман в 2001 году в Университете Калифорнии, Беркли. Его идея заключалась в построении множества деревьев решений на случайных подвыборках данных и признаков, что делает модель устойчивой к переобучению и шуму.

Современные банки сталкиваются с задачей интеграции ESG-критериев в процесс оценки кредитоспособности. Традиционные статистические методы не всегда позволяют учесть сложные взаимосвязи между финансовыми показателями и нефинансовыми факторами. Здесь на помощь приходят ансамблевые алгоритмы машинного обучения. Случайный лес и градиентный бустинг способны работать с разнородными данными, выявлять скрытые закономерности и формировать интерпретируемые модели, которые помогают кредитным аналитикам принимать более взвешенные решения.

Для оценки кредитоспособности заемщиков с учётом ESG-критериев предлагается использовать ансамблевые методы машинного обучения — градиентный бустинг и случайный лес. Эти алгоритмы позволяют работать с разнородными данными, включающими как количественные финансовые показатели (выручка, долговая нагрузка, ликвидность), так и качественные ESG-метрики (экологическая политика компании, социальные инициативы, структура корпоративного управления).

Подготовка данных включает несколько этапов:

1) Сбор информации из финансовой отчётности и специализированных ESG-рейтинговых агентств;

2) Очистка и нормализация данных для устранения пропусков и несоответствий;

3) Кодирование категориальных признаков, таких как наличие экологической сертификации или участие в социальных программах;

4) Формирование обучающей выборки, где целевая переменная отражает факт одобрения или отказа в кредите [1, p.17].

Обособленная разность методов очень растяжима.

Случайный лес строит множество деревьев решений, каждое из которых обучается на случайной подвыборке признаков и данных. Итоговое решение формируется путём агрегирования результатов всех деревьев. Такой подход снижает риск переобучения и делает модель устойчивой к шуму, что особенно важно при работе с ESG-данными, где часть показателей может быть субъективной или неполной.

Градиентный бустинг обучает последовательность деревьев, каждое из которых исправляет ошибки предыдущего. Алгоритм минимизирует функцию потерь, приближая её градиент. Это позволяет достигать высокой точности прогнозов и выявлять сложные нелинейные зависимости между финансовыми и ESG-факторами.

Существует ряд метрик, которые специалисты во многих банках используют, как показатель при дополнительном анализе заемщике, такие как метрики оценки качества. Данные метрики используются для проверки эффективности моделей:

a) ROC-AUC — оценка качества бинарной классификации;

b) F1-score — баланс между точностью и полнотой;

c) Accuracy — общая точность модели [2, p.3];

d) Интерпретируемость (SHAP-значения) — анализ вклада каждого признака в итоговое решение.

Применение ансамблевых алгоритмов позволяет банкам не только повысить точность прогнозирования кредитных рисков, но и выявить ключевые ESG-факторы, влияющие на вероятность дефолта. Например, наличие прозрачной системы корпоративного управления может снижать риск невозврата кредита, а высокая углеродная нагрузка — наоборот, увеличивать его.

На сегодняшний день градиентный бустинг (gradient boosting machine) является одним из основных production-решений при работе с табличными, неоднородными данными, поскольку обладает высокой производительностью и точностью [3, p.5].

Алгоритм работает следующим образом:

a) Строится базовое дерево решений, которое делает первичный прогноз вероятности дефолта;

b) Вычисляются ошибки прогноза, и на их основе формируется новое дерево, корректирующее результат;

c) Процесс повторяется многократно, каждое дерево добавляет уточнение, приближая модель к оптимальному решению;

d) Итоговый прогноз формируется как сумма всех деревьев, взвешенных по коэффициентам обучения.

Для оценки качества модели применяются метрики ROC-AUC, F1-score и анализ интерпретируемости с помощью SHAP-значений, которые позволяют определить вклад каждого ESG-фактора в итоговое решение. Например, модель может показать, что высокий уровень выбросов CO_2 увеличивает вероятность отказа в кредите, а наличие независимого совета директоров снижает риски [4, p.5].

Алгоритм Random Forest был предложен Лео Брейманом в 2001 году и стал одним из самых популярных методов машинного обучения для задач классификации и регрессии. Его ключевая идея заключается в построении множества деревьев решений, каждое из которых обучается на случайной подвыборке данных и признаков. Итоговое решение формируется путём агрегирования результатов всех деревьев — например, голосованием в задаче классификации или усреднением в задаче регрессии. Такой подход снижает риск переобучения и делает модель устойчивой к шуму. В контексте банковского кредитования с учётом ESG-критериев Random Forest позволяет анализировать широкий спектр признаков, включая:

1) Финансовые показатели: ликвидность, долговая нагрузка, рентабельность;

2) Экологические факторы: углеродный след компании, наличие экологических сертификатов;

3) Социальные факторы: участие в социальных инициативах, соблюдение трудовых прав;

4) Управленческие факторы: прозрачность корпоративного управления, независимость совета директоров [5, p.7].

Особенность Random Forest заключается в том, что он хорошо работает с данными, где признаки могут быть скоррелированы или содержать шум. Для ESG-оценки это особенно важно, так как часть показателей может быть субъективной или неполной. Модель способна выявлять значимые факторы даже в условиях высокой вариативности данных.

Пример применения Random Forest в кредитном процессе:

a) Формируется обучающая выборка с финансовыми и ESG-показателями компаний;

b) Строится множество деревьев решений, каждое из которых обучается на случайной подвыборке признаков;

c) Итоговое решение формируется путём агрегирования результатов всех деревьев.

Анализ важности признаков позволяет определить, какие ESG-факторы наиболее сильно влияют на вероятность дефолта.

Для оценки качества модели применяются метрики ROC-AUC, F1-score и анализ важности признаков. Например, Random Forest может показать, что наличие экологической сертификации снижает вероятность дефолта, а высокая углеродная нагрузка увеличивает риски.

Таким образом, Random Forest (далее RF) является надёжным инструментом для интеграции ESG-критериев в кредитный процесс. Он обеспечивает устойчивость модели к шуму, позволяет выявлять ключевые факторы устойчивости и помогает банкам принимать более взвешенные решения при выдаче кредитов [6, p.3].

Стоит подчеркнуть, что данные методы отличаются подходами в обучении. Random Forest строит множество деревьев решений параллельно, каждое на случайной подвыборке данных и признаков. Итоговое решение формируется путём агрегирования результатов всех деревьев [7, p.10].

Gradient Boosting Machine (далее GBM) строит деревья последовательно, каждое новое дерево исправляет ошибки предыдущего, минимизируя функцию потерь.

RF лучше справляется с шумными и неполными данными, что важно для ESG-метрик, где часть показателей может быть субъективной или неполной. GBM более чувствителен к качеству данных, но способен выявлять сложные нелинейные зависимости между финансовыми и ESG-факторами [8, p.9].

Важную роль играет интерпретируемость. RF предоставляет простую оценку важности признаков (feature importance), позволяя понять, какие ESG-факторы влияют на решение. GBM требует более сложных инструментов интерпретации (например, SHAP-значения), но даёт более детализированное объяснение вклада каждого признака.

В банковской сфере уже есть примеры использования данных методах, однако, неполностью доказана их значимость при техническом анализе. RF больше подходит для быстрых пилотных проектов и ситуаций, где важна устойчивость модели к шуму. GBM же предпочтителен для задач, где требуется максимальная точность и возможность выявления сложных взаимосвязей между ESG-факторами и кредитным риском [10, p.1].

Оба метода дополняют друг друга: RF обеспечивает надёжность и устойчивость, а GBM — высокую точность и гибкость. В банковской практике целесообразно использовать их совместно: RF — для первичной оценки и отбора признаков, GBM — для построения точных скоринговых моделей, учитывающих ESG-критерии (табл. 1).

Таблица 1

Таблица сравнения GBM и RF для ESG-кредитования

Критерий	Gradient Boosting Machine (GBM)	Random Forest (RF)
Принцип работы	Последовательное построение деревьев, каждое исправляет ошибки предыдущего	Параллельное построение множества деревьев на случайных подвыборках
Точность прогнозов	Обычно выше при правильной настройке гиперпараметров	Стабильная, но может уступать GBM
Устойчивость к шуму	Чувствителен к качеству данных	Высокая устойчивость к шумным и неполным данным
Интерпретируемость	Требует сложных методов (SHAP, LIME), но даёт детализированные объяснения	Простая оценка важности признаков, легко понять вклад ESG-факторов
Скорость обучения	Медленнее, особенно на больших выборках	Быстрее, хорошо масштабируется
Применимость к ESG	Выявляет сложные нелинейные зависимости между финансовыми и ESG-факторами	Надёжно работает при высокой вариативности и неполноте ESG-данных
Риск переобучения	Высокий при неправильной настройке	Низкий благодаря случайности и усреднению
Практическая роль	Подходит для построения точных скоринговых моделей	Эффективен для первичной оценки и отбора признаков

Как и в случае с Adaboost, градиентный бустинг добавляет базовые модели в ансамбль последовательно, однако вместо обучения моделей с учётом весов на основе ошибок предшественников, в данном случае модели обучаются на остаточных ошибках (residual errors), допущенных предыдущими моделями.

Существует два принципа работы GBM, для регрессии и для классификации:

Алгоритм строится следующим образом:

1) первоначальному прогнозу присваивается среднее значение y_train для всех образцов;

2) рассчитываются остатки модели на основе антиградиента функции потерь;

3) регрессионное дерево обучается на X_train и остатках, далее делается прогноз на X_train;

4) полученный прогноз добавляется к первоначальному и шаги 2-4 повторяются для каждого дерева;

5) после обучения всех моделей снова создаётся первоначальный прогноз из шага 1;

6) далее делаются прогнозы для X_test на обученных деревьях и добавляются к первоначальному;

7) полученная сумма и будет конечным прогнозом.

Когда мы изучаем классическое машинное обучение, неизбежно сталкиваемся с парадоксом: материалов по теме много, но интуитивно понятных объяснений того, почему ансамбли настолько эффективны, — удивительно мало. Попробуем восполнить этот пробел и разложить концепцию ансамблей по полочкам.

Ансамбли представляют собой особую парадигму машинного обучения. В её основе лежит идея объединения нескольких моделей, каждая из которых по отдельности может быть «слабой» в решении задачи. Однако вместе они формируют систему, способную выдавать значительно более точные и устойчивые результаты.

Главная мысль проста: множество слабых алгоритмов, действующих сообща, превращаются в один сильный. Это похоже на коллективное решение, где каждый участник вносит свой вклад, а итоговое решение оказывается более надёжным, чем мнение одного эксперта [9, p.4].

Чтобы понять силу ансамблей, нужно вспомнить, из чего складывается ошибка модели. В машинном обучении принято выделять три компонента:

1. Смещение (bias) — систематическая ошибка, возникающая из-за упрощённых предположений модели;
2. Разброс (variance) — чувствительность модели к конкретным данным, из-за чего результаты могут сильно колебаться;
3. Шум — неизбежная часть данных, которую невозможно устранить полностью.

$$Error = bias^2 + variance + noise \quad (1)$$

Ансамбли помогают сбалансировать эти составляющие. Объединяя разные модели, мы снижаем разброс, уменьшаем влияние смещения и получаем более устойчивый результат. В итоге система оказывается менее подверженной случайным ошибкам и лучше справляется с задачами, чем отдельные алгоритмы (рис.1).

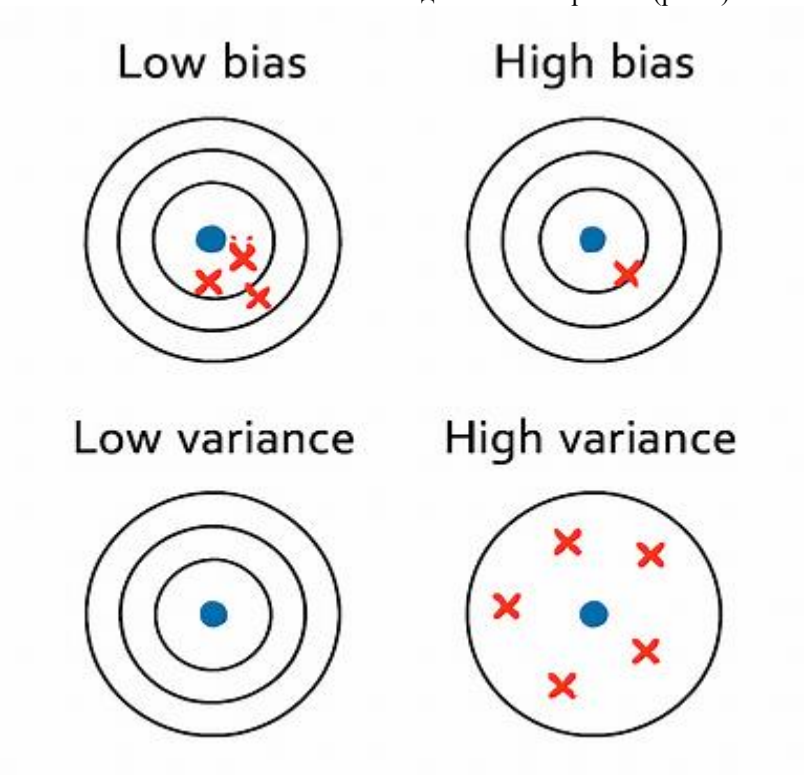

Рисунок 1

Когда мы смотрим на «мишени» для смещения и разброса, мы фактически визуализируем два аспекта ошибки модели: где в среднем бьём относительно цели (смещение) и насколько далеко разбросаны отдельные попадания (разброс). Это помогает понять характер ошибок и выбрать стратегии улучшения модели.

Разброс показывает, насколько прогнозы модели колеблются. Высокий разброс — признак переобучения: модель слишком чувствительна к данным и выдаёт разные ответы в зависимости от выборки. Низкий разброс означает устойчивость: результаты стабильны, но при высоком смещении они могут быть стабильно неверными. В идеале мы стремимся к низкому смещению и низкому разбросу — тогда модель и точна, и надёжна. Именно ансамбли помогают приблизиться к этой цели: Случайный Лес снижает разброс, а Градиентный Бустинг уменьшает смещение.

Именно в этом и заключается суть градиентного бустинга. Вместо того чтобы напрямую минимизировать сложную функцию потерь, алгоритм на каждом шаге строит новое дерево, которое пытается предсказать градиент этой функции — то есть направление, в котором ансамбль ошибается.

Проще говоря, каждое последующее дерево добавляется для исправления наиболее заметных промахов предыдущих моделей. Подробное объяснение математической основы заслуживает отдельного разбора, но именно идея обучения на градиенте ошибки и дала название этому методу.

Для начала анализа загрузим все необходимые нам библиотеки:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.datasets import load_diabetes
from sklearn.preprocessing import LabelEncoder
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score, mean_absolute_percentage_error
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import GradientBoostingClassifier, GradientBoostingRegressor
from sklearn.ensemble import HistGradientBoostingClassifier, HistGradientBoostingRegressor
from mlxtend.plotting import plot_decision_regions (2)
```

Каждый импорт в твоём коде выполняет свою роль и нужен для определённых задач. Библиотеки NumPy и Pandas обеспечивают работу с данными: первая отвечает за быстрые численные операции с массивами, а вторая — за удобное хранение и обработку табличных структур. Matplotlib используется для построения графиков и визуализации результатов. Встроенный датасет load_diabetes из sklearn.datasets служит примером для регрессионных задач, а LabelEncoder помогает преобразовать категориальные признаки в числовые значения.

Для подготовки данных применяется train_test_split, который делит выборку на обучающую и тестовую части. Метрики accuracy_score и mean_absolute_percentage_error позволяют оценить качество моделей: первая — для классификации, вторая — для регрессии. Среди моделей у тебя есть DecisionTreeRegressor — базовое дерево решений для регрессии, а также ансамблевые методы: GradientBoostingClassifier и GradientBoostingRegressor для классического градиентного бустинга, и их более современный вариант — HistGradientBoostingClassifier и HistGradientBoostingRegressor, оптимизированные для больших данных. Наконец, функция plot_decision_regions из библиотеки MLxtend используется для наглядной визуализации областей решений классификаторов, показывая, как модель разделяет классы на плоскости.

Попробуем выполнить на языке python:

```
import numpy as np
import pandas as pd
from sklearn.tree import DecisionTreeRegressor
class SimpleGBMClassifier:
def __init__(self, learning_rate=0.1, n_estimators=100, max_depth=3, random_state=0):
self.learning_rate = learning_rate
self.n_estimators = n_estimators
self.max_depth = max_depth
self.random_state = random_state
def _softmax(self, logits):
exp_logits = np.exp(logits - np.max(logits, axis=1, keepdims=True))
return exp_logits / np.sum(exp_logits, axis=1, keepdims=True)
def fit(self, X, y):
self.classes_ = np.unique(y)
self.K = len(self.classes_)
self.trees = [[] for _ in range(self.K)]
y_onehot = pd.get_dummies(y).values
predictions = np.zeros_like(y_onehot)
for _ in range(self.n_estimators):
probs = self._softmax(predictions)
for k in range(self.K):
residuals = y_onehot[:, k] - probs[:, k]
tree = DecisionTreeRegressor(max_depth=self.max_depth, random_state=self.random_state)
tree.fit(X, residuals)
self.trees[k].append(tree)
predictions[:, k] += self.learning_rate * tree.predict(X)
def predict(self, X):
scores = np.zeros((X.shape[0], self.K))

for k in range(self.K):
for tree in self.trees[k]:
scores[:, k] += self.learning_rate * tree.predict(X)
return self.classes_[np.argmax(scores, axis=1)] (3)
```

Данный код реализует класс GBMClassifier, который представляет собой классификатор на основе градиентного бустинга.

В классе GBMClassifier определены следующие методы:

1) _softmax — функция для преобразования прогнозов в вероятности с помощью softmax-функции;
2) _compute_gammas — функция для вычисления коэффициентов \gamma, которые регулируют степень вклада каждого нового дерева в общую модель;
3) fit — метод для обучения модели на данных;
4) predict — метод для прогнозирования классов объектов.

Особенностью данного классификатора является возможность использования концепции K-class LogitBoost, которая позволяет улучшить качество прогнозов за счёт расчёта весов для каждого дерева и использования их при вычислении остатков.

Этот код может быть полезен для решения задач классификации с использованием градиентного бустинга, особенно в случаях, когда необходимо улучшить качество прогнозов или учесть специфику данных.

```
def decision_boundary_plot(X, y, X_train, y_train, clf, feature_indexes, title=None):
feature1_name, feature2_name = X.columns[feature_indexes]
```

```
X_feature_columns = X.values[:, feature_indexes]
X_train_feature_columns = X_train.values[:, feature_indexes]
clf.fit(X_train_feature_columns, y_train.values)

plot_decision_regions(X=X_feature_columns, y=y.values, clf=clf)
plt.xlabel(feature1_name)
plt.ylabel(feature2_name)
plt.title(title) (4)
```

Функция decision_boundary_plot предназначена для визуализации решающих границ классификатора. Она принимает на вход данные (X и y), обучающую выборку (X_train и y_train), классификатор (clf) и индексы признаков, которые будут использоваться для построения графика.

Функция извлекает имена признаков, соответствующие указанным индексам, затем подгоняет классификатор к обучающей выборке и использует функцию plot_decision_regions для построения графика решающих границ. Оси графика помечаются именами признаков, а заголовок графика задаётся параметром title.

Этот код полезен для визуализации работы классификатора и анализа его решений в пространстве признаков.

Для задач прогнозирования кредитоспособности предприятий по ESG-факторам банки используют специализированные коммерческие наборы данных, такие как S&P Global ESG Scores, LSEG ESG Company Data или SIX ESG Data Hub. Эти датасеты содержат показатели устойчивого развития (экология, социальная ответственность, корпоративное управление), которые можно связать с финансовыми метриками для оценки риска и кредитоспособности.

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MODEL APPROACH TO ASSESSING THE IMPACT OF ESG FACTORS ON THE BANKING SECTOR

Korchinsky A.
Postgraduate student of the Faculty of Economics
Belarusian State University
Minsk, Republic of Belarus

МОДЕЛЬНЫЙ ПОДХОД К ОЦЕНКЕ ВЛИЯНИЯ ESG-ФАКТОРОВ НА БАНКОВСКУЮ СФЕРУ

Корчинский А.С.
аспирант экономического факультета
Белорусский государственный университет
г. Минск, Республика Беларусь
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Abstract

The article presents a model analysis of the influence of ESG factors on the effectiveness of the banking sector. The consolidated ESG efficiency index is used as a methodological basis, which allows aggregating various indicators of sustainable development into a single quantitative indicator. Developing the approach of integrating ESG criteria into the assessment of banking activity, the dynamics of ESG-oriented development of banks is investigated, which allows for a comparative analysis of their stability and effectiveness. The key factors determining the impact of ESG strategies on the financial performance and risks of banks have been identified, and based on the dynamics of the consolidated ESG performance indices, conclusions have been drawn about trends and prospects for integrating sustainable development into the banking sector.

Аннотация

В статье представлен модельный анализ влияния ESG-факторов на эффективность банковского сектора. В качестве методологической основы используется сводный индекс ESG-эффективности, позволяющий агрегировать различные показатели устойчивого развития в единый количественный индикатор. Развивая подход интеграции ESG-критериев в оценку банковской деятельности, исследуется динамика ESG-ориентированного развития банков, что позволяет провести сравнительный анализ их устойчивости и эффективности. Выявлены ключевые факторы, определяющие влияние ESG-стратегий на финансовые показатели и риски банков, а на основе динамики сводных индексов ESG-эффективности сделаны выводы о тенденциях и перспективах интеграции устойчивого развития в банковский сектор.

Keywords: ESG factors; banking sector; sustainable development; composite index; model analysis; financial efficiency; risk management; corporate social responsibility; green financing; sustainable investments.

Ключевые слова: ESG-факторы; банковский сектор; устойчивое развитие; сводный индекс; модельный анализ; финансовая эффективность; управление рисками; корпоративная социальная ответственность; зеленое финансирование; устойчивые инвестиции.

Соблюдение и достижение новых стандартов, для выполнения целей устойчивого развития (далее – ЦУР) в Республике Беларусь включает в себя экологическую устойчивость, социальную справедливость, экономическое развитие, политическую волю и общественное участие. Это проявляется в сохранении биоразнообразия и эффективном управлении природными ресурсами, обеспечении доступа к качественному образованию и медицинским услугам, поддержке экологически чистых технологий привлечении инвестиций в новые, прибыльные и устойчивые проекты.

Для этого 1 июня 2023 года было разработано Руководство по применению экологических, социальных и управленческих стандартов (ESG-стандартов) субъектами хозяйствования в Республике Беларусь. Устойчивое развитие является примером социального развития, обеспечивающего удовлетворение потребностей нынешнего поколения без ущерба для удовлетворения потребностей будущих поколений. Модель устойчивого развития обеспечивает развитие общества одновременно по трем важным направлениям: экономическому, социальному и экологическому [1, p.3].

Данные цели охватывают разнообразные ключевые сферы, включая искоренение бедности, борьбу с голодом, обеспечение качественного образования, достижение гендерного равенства, защиту окружающей среды и содействие устойчивому экономическому росту. Для обеспечения достижения ЦУР необходимо признавать необходимость учета ожиданий заинтересованных сторон и долгосрочных последствий при планировании и реализации стратегических целей и задач, а также внедрять новые научные исследования и практические методы в различные сферы экономики и общества в целом.

Для обеспечения достижения ЦУР необходимо быстро реагировать на современные вызовы и угрозы, чтобы не допустить ухудшения ситуации в будущем. Применение ЦУР находит отражение как

на макроуровне в национальных стратегиях развития, так и на уровне отдельных отраслей, домашних хозяйств и бизнеса. С целью своевременного мониторинга оценки деятельности компаний по экологическому направлению, социальному и управленческому были разработаны различные критерии и принципы, которые сформулированы в ESG-повестке.

В Беларуси широкое изучение ESG-повестки началось в 2022 г., когда были предложены различные точки зрения, мнения, также советы, коллегии, кроме того, по данной тематике начали проводиться исследования и публиковаться научные статьи. Так, Грузневичем Е.С. была изучена модель архитектуры управления устойчивым развитием Республики Беларусь на основе инфраструктуры ESG, где предусматривается, что для повышения эффективности деятельности субъектам хозяйствования необходимо привлекать инвестиции, одним из видов которых является устойчивое, «зеленое» финансирование и предлагается использование ESG-инструментов организациями для получения ими доступа к устойчивому, «зеленому» финансированию [2, p.15]. В условиях банковской сферы А. Жилич обусловила *эффективность ESG-инвестирования для Республики Беларусь*, а именно классификацию ESG-терминов, анализируя как ключевые институты, так и характеристику уже на сегодняшний день известных ESG-рейтингов [3, p.12]. Более детально и конкретно Е. Машнина и Л. Германович указали на риски банков при «зелёном» финансировании и основные направления ESG-повестки в современных реалиях [4, p.28]. С. Дубков в своей работе описал роль банковского сообщества в достижении ЦУР, которое выражено анализом информации о новых и возможных ESG-принципов на современном этапе и общее вовлечение белорусских банков в ESG-повестку и достижение ЦУР [5, p.5].

Информация, которая предоставлена рейтинговым агентством Республики Беларусь, недостаточно подробно анализирует деятельность ESG-повестки, подчеркивая то, что в рамках ESG-подхода банк рассматривается только как субъект хозяйствования, не включая анализ его клиентов, процессы и механизмы финансирования и ведения бизнеса [6, p.17].

Однако для обеспечения качественного развития банковского сектора необходимо учитывать современные тенденции регуляторного воздействия на финансовые организации на международном уровне. Эксперт Белоусов А. Л. отметил, что одним из главных трендов последних лет в России является широкое применение ESG-подхода в построении и развитии бизнес-процессов, и привел проблематику, связанную с расширением внедрения ESG-стандартов в финансовом секторе, обусловленную имеющимися ограничениями [7, p.10]. При этом большая часть ограничений носит в настоящее время общемировой характер и требует решения на глобальном уровне. В частности, данные проблемы исходят от специалистов, которые не до конца понимают повестку ESG-стандартов и не в состоянии разработать новые подходы. Касательно банковской сферы такие вопросы возникают по влиянию ESG-факторов на стоимость капитала, стоимость заемных средств, денежный поток и чистую процентную маржу. В. Азми, К. Хассан и Р. Хьюстон провели анализ, который показал, что стоимость капитала не является тем каналом, через который ESG-активности способствуют повышению производительности. Предполагается, что банки, соответствующие ESG-стандартам, смогут снизить издержки, связанные с асимметричной информацией, что, в свою очередь, должно привести к снижению стоимости их капитала [8, p.19].

С учетом этого, ESG-переход начал восприниматься как «философия бизнеса», которая формирует деловую репутацию банка и способствует доверию к его деятельности. В своем исследовании Довбий И.П., Кобылякова В.В. и др. показали, что «зеленые» банки играют ключевую роль в «озеленении» экономики и финансовой системы, поскольку являются кредитными организациями, создаваемыми для ускорения перехода к устойчивой экономике, выполняющие задачу привлечения инвестиций в «зеленые» проекты для достижения ЦУР посредством создания и предложения инвесторам финансовых продуктов «зеленого» качества [9, p.21]. Обусловлено это привязкой финансовых инструментов к устойчивому развитию, что является естественно обусловленным процессом, но характеризуется «взрывными» темпами роста. Свидетельством этому является глобальный объем выпуска ESG-облигаций, общий объем эмиссии которых составил более 1 трлн. долл. США в 2024 г., при этом «зеленые» облигации составили 60% [10, p.17].

Проект Национальной стратегии устойчивого развития Республики Беларусь на период до 2040 года также предусматривает внедрение ESG-инструментов финансирования в банковской сфере, которые включают «зеленые» и социальные облигации, кредиты, проектное финансирование, создание банка «зеленых» инвестиций и др. Реализация данного Проекта является ключевым элементом достижения устойчивого экономического роста и социальной справедливости [11, p.32]. Эти и другие инструменты помогут интегрировать экологические, социальные и управленческие факторы в финансовые процессы, что позволит обеспечить более ответственное использование ресурсов и минимизировать негативное воздействие на окружающую среду. Стратегия включает в себя создание благоприятных условий для привлечения инвестиций в проекты, соответствующие принципам устойчивого развития, а также развитие механизмов оценки и мониторинга ESG-эффективности. Внедрение таких инструментов будет способствовать повышению прозрачности и ответственности бизнеса, что, в свою очередь, может улучшить имидж страны на международной арене и привлечь дополнительные зарубежные инвестиции, кроме того, банки смогут структурировать дополнительные средства для дальнейшего «зеленого» финансирования проектов на территории Республики Беларусь.

Программа социально-экономического развития Республики Беларусь на 2021–2025 годы, утвержденная Указом Президента Республики Беларусь №292 от 29 июля 2021 года, рассматривает внедрение финансовых инструментов для поддержки зеленой экономики как одно из приоритетных направлений на среднесрочную перспективу [12, p.3]. Это направление будет сохранено и в будущей Программе социально-экономического развития страны на 2026-2030 гг.

Национальный план действий по развитию зеленой экономики в Беларуси на 2021–2025 годы, утвержденный 10 декабря 2021 года Постановлением Совета Министров № 710, также включает ряд мероприятий по развитию «зеленого» финансирования: «применения ESG-рейтингования, расширение линейки инструментов финансирования «зеленых» проектов и совершенствование механизма их финансирования» и др. (мероприятия 51-58) [13, p.4]. Одним из результатов реализации данных мероприятий (мероприятие 51) станет анализ международного опыта в области ESG-рейтингования и подготовка рекомендаций по его внедрению в национальную практику.

В данной работе представлено условное практическое дополнение к исследованию Семеновой Н.Н. и Кормишкина Е.Д. «Реализация ESG-повестки в банковском секторе: обзор российской практики», в котором авторы на основе анализа рейтинговых агентств предлагают развить теорию ESG-повестки и обосновать присвоенные банкам Российской Федерации ESG-рейтинги [14, p.10]. Согласно Э. Д. Бейкеру и Т. Дж. Боултону, вкладчиков, точно также, как и инвесторов, привлекает прибыль от вложенных ими денежных средств с учетом ESG-факторов, оказывающих влияние на принятие инвестиционных решений [15, p.8]. Согласно данным Фонда климатических инвестиций (Climate Investment Funds, SIF) США, на начало 2018 года в США было зарегистрировано активов на сумму около 11,6 трлн. долларов, для которых инвестиционные менеджеры применяли ESG-критерии при принятии решений о распределении инвестиций и формировании портфелей. Это число увеличилось на 44% по сравнению с двумя годами ранее. В конце 2023 года общая сумма активов, использующих ESG-критерии, возросла до 19,1 трлн. долларов США [16, p.9]. Также подчеркивается важность ESG-повестки при первичном публичном размещении акций (IPO): если ESG-рейтинги связаны с меньшей асимметрией информации, то заниженная цена IPO должна быть ниже для компаний, зарегистрированных в странах с более высокими ESG-рейтингами. С другой стороны, если более высокие ESG-рейтинги привлекают внимание инвесторов, занижение цен должно быть большим для IPO в странах с более высокими ESG-рейтингами.

Для Беларуси это означало бы, что при повышении ESG-рейтингов белорусских компаний, организаций и банков, инвесторы могут быть более склонны доверять им, что может привести к меньшему занижению цен IPO. Если же белорусские компании станут активно внедрять ESG-стандарты и добьются высоких рейтингов, это может не только привлечь внимание инвесторов, но и повысить привлекательность их акций на международных рынках.

Согласно мнению экспертов, внедрить эффективную политику и практику ESG-стандартов в странах с недостаточно развитой правовой базой или сталкивающихся с политическими и экономическими трудностями крайне сложно. Это требует значительных усилий для адаптации законодательства и обеспечения соблюдения стандартов, а также создания инфраструктуры для мониторинга и отчетности.

В рамках модельного анализа влияния ESG-факторов на эффективность банковского сектора могут быть использованы следующие модели математического моделирования:

1) Модель машинного обучения (градиентный бустинг, случайный лес) – для прогнозирования влияния ESG-факторов на финансовую устойчивость банков;

2) Метод стохастического моделирования – для учета неопределенности и рисков, связанных с влиянием ESG-факторов на банковскую деятельность;

3) Модель оболочечного анализа данных или модель сравнительного анализа конкуренции DEA – для оценки эффективности банков с учетом ESG-критериев в сравнении с конкурентами.

Методы машинного обучения, такие как градиентный бустинг (XGBoost, LightGBM, CatBoost) и случайный лес (Random Forest) используются для прогнозирования влияния ESG-факторов на финансовую устойчивость банков:

a) Градиентный бустинг (XGBoost, LightGBM, CatBoost) – метод способный учитывать сложные нелинейные зависимости между ESG-факторами и финансовыми показателями;

b) Случайный лес (Random Forest) – ансамблевая модель на основе решающих деревьев, устойчива к выбросам и переобучению, подходит для выявления значимости ESG-факторов.

Метод градиентного бустинга более подходит для изучения из-за неполноты данных. Для применения градиентного бустинга (например, XGBoost, LightGBM, CatBoost) в задаче прогнозирования влияния ESG-факторов на финансовую устойчивость банков необходимо включать целевую переменную (далее — ЦП) или таргет — например, ROA (рентабельность активов), ROE (рентабельность капитала), NPL (доля проблемных кредитов) или ESG-рейтинг. Метрика качества будет обозначать среднюю абсолютную ошибку MAE (Mean Absolute Error). За интерпретацию результатов выбирается Feature Importance, поскольку она более простая в использовании и указывает какие ESG-факторы больше всего влияют на финансовую устойчивость.

Стохастическое моделирование подразделяется на несколько категорий, каждая из которых сосредоточена на различных аспектах анализа и прогнозирования. К основным типам относятся моделирование временных рядов, использующееся для анализа и прогнозирования данных, собранных во

времени, что позволяет выявлять тренды и сезонные колебания.

Сценарное моделирование создает различные сценарии будущего, учитывая неопределенности, что особенно полезно для оценки влияния различных факторов на результаты. Метод Монте-Карло, который использует случайные числа для моделирования и анализа вероятностных процессов, применяется для оценки рисков и неопределенностей в сложных системах.

Стохастические дифференциальные уравнения моделируют динамику систем с произвольными элементами, что важно в финансовых моделях и экономике. Агентное моделирование, в свою очередь, фокусируется на взаимодействиях между автономными агентами и может использоваться для изучения сложных систем и их поведения.

На примере методики Data Envelopment Analysis (далее метод DEA), разработанной А. Чарнсом, У. Купером, Э. Роудсом [17, p.2] в 1978 году на основе идей М. Фаррела о технической эффективности объекта [18, p.3], и применяемую белорусскими учеными для экономического анализа эффективности работы объектов, в работе построена собственная модель DEA, состоящая из входных и выходных показателей, на основе годовых финансовых показателей банков Республики Беларуси за 2024 год [19, p.1]. Основой методики DEA является предположение о том, что все участники группы работают в равных рыночных условиях, что позволяет им, учитывая масштабы своей деятельности, достигать результатов, сопоставимых с лучшими банками [20, p.1].

Модель DEA может быть полезна при оценке банков Республики Беларусь по ESG-факторам несколькими способами. Во-первых, она позволяет проводить сравнительный анализ эффективности банков на основе их ESG-показателей (данные показатели отбирались в сравнении с наилучшими показателями за 2024 г.), выявляя лучшие практики и области для улучшения. Во-вторых, модель помогает определить банки, демонстрирующие наилучшие результаты в области устойчивого развития, что может служить примером для других участников рынка благодаря учету множества факторов одновременно, что важно для комплексной ESG-оценки, включающей экологические, социальные и управленческие аспекты. И в-третьих, модель способствует выявлению возможностей для оптимизации ресурсов, позволяя банкам более эффективно достигать высоких результатов в деятельности ЦУР.

В рамках данного исследования в статье рассмотрена модель DEA для анализа эффективности 10 банков Республики Беларусь, отобранных по показателю собственного капитала на 1 января 2025 г.

На основе входных показателей были использованы данные:

1) Информация о депозитах юридических лиц в банках Республики Беларусь (млн. бел. руб.);

2) Информация о переводных депозитах юридических лиц в банках Республики Беларусь (млн. бел. руб.);

3) Информация о депозитах физических лиц в банках

Республики Беларусь (млн. бел. руб.);

а для выходных:

1) Информация о выдаче кредитов банками Республики Беларусь физическим лицам (млн. бел. руб.);

2) Задолженность по кредитам, выданным банками Республики Беларусь юридическим лицам (млн. бел. руб.);

3) Объем выдачи кредитов банками* юридическим лицам (млн. бел. руб.) (табл. 1).

При построении модели DEA используется программное обеспечение DEAFrontier[1] с дополнительными надстройками и макросами для осуществления автоматизации расчетов, упрощения анализа больших данных и, в конечном итоге, минимизации риска вероятности ошибок, связанных с ручным вводом данных, а также получения более точных результатов для сравнения исследуемых объектов.

Данный метод также позволит оценить, какие из банков более ориентированы на внедрение ESG-стандартов для бизнеса, поскольку выполнение повестки ЦУР необходимо для улучшения экономического роста Республики Беларусь. Под внедрением новых ESG-стандартов подразумевается исключительно практическое применение, включая создание и продвижение банковских продуктов и услуг для юридических лиц.

Данный метод позволяет анализировать переменные исходя из предоставленных значений. На основе полученного результата выведена общая эффективность, выраженная в процентах, что может свидетельствовать о доступности ресурсов (100% - полностью доступны, 0% - не доступны).

[1] DEAFrontier — надстройка для Microsoft Excel, разработанная профессором Джо Чжу для выполнения расчётов в рамках анализа оболочек данных (DEA).

Таблица 1

Показатели отдельных банков Республики Беларусь за 2024 г., млн. бел. руб.

№	Банк	Входные			Выходные		
		Данные о депозитах юридических лиц* в банках	Сведения о переводных депозитах юридических лиц* в	Статистика по депозитам физических лиц в банках	Отчёт о выдаче кредитов банками физическим лицам	Задолженность по кредитам, выданным банками юридическим лицам	Объем выдачи кредитов банками* юридическим лицам
1	Банк 1	9 647,6	5 386,9	15 620,8	5 909,5	26 893,6	42 905,7
2	Банк 2	5 527,8	1 082,9	5 073,7	1 515,6	10 845,7	16 531,5
3	Банк 3	3 432,8	3 231,4	2 445,0	777,2	1 900,2	11 750,2
4	Банк 4	3 115,7	1 506,2	2 385,7	1 718,5	3 022,0	20 955,3
5	Банк 5	3 087,4	1 459,9	984,5	615,5	3 559,3	16 826,4
6	Банк 6	2 323,2	1 062,9	1 578,0	1 182,7	2 253,0	12 304,0
7	Банк 7	2 112,6	571,6	1 044,2	396,5	2 283,5	11 671,5
8	Банк 8	1 786,0	882,4	1 588,8	953,2	2 396,2	6 210,6
9	Банк 9	2 006,2	816,7	925,3	1 849,7	1 523,2	7 315,0
10	Банк 10	1 194,9	148,8	482,6	611,8	1 213,1	8 888,2

Источник: составлено авторами на основе данных myfin.by, BIK-ratings, Национального банка Республики Беларусь, banki.by.

** Без учета данных по банкам, находящимся в стадии ликивидации.*

Проанализируем эффективность на основе следующих показателей (табл. 2):

1. эффективность использования ресурсов (Input-Oriented CRS Efficiency) – измеряет эффективность использования ресурсов (входов) для достижения определенного уровня выходов. Значение 1,000 означает, что данный объект использует ресурсы оптимально. Значения ниже 1 указывает на неэффективность, т.е. необходимость сокращения входов для достижения тех же параметров выхода;

2. сумма весов (Sum of Lambdas) - показатель, который модель DEA назначает другим объектам в качестве бенчмарков для оценки эффективности: чем выше сумма, тем больше влияние других объектов на оценку исследуемого объекта. Если сумма весов для текущего объекта равна 1, то это означает, что он полностью ориентирован на свои собственные параметры выхода;

3. эффект масштаба или рентабельность масштаба (Returns to Scale) –указывает на тип отдачи от масштаба, с которым работает объект, а именно:

a) постоянный (constant) - упорядоченные входы и выходы сохраняются пропорционально при увеличении масштаба;

b) возрастающий (increasing) - увеличение входов приводит к более чем пропорциональному увеличению выходов;

c) нисходящий (decreasing) - увеличение входов приводит к менее чем пропорциональному увеличению выходов.

Дополнительный показатель оптимальные лямбда по эталону (Optimal Lambdas with Benchmarks) указывает на оптимальные веса (лямбда), назначенные другим объектам, которые служат эталонами для данного объекта, т.е. показывают как каждый объект использует ресурсы других для достижения своей эффективности. Более высокие значения лямбда указывают на большую зависимость от других объектов.

Эти показатели комплексно позволяют анализировать и сравнивать эффективность различных организаций, выявляя возможности для улучшения.

Таблица 2

Модель DEA банков Республики Беларусь по эффективности

№ объекта	Наименование объекта	Эффективность использования ресурсов (Input-Oriented CRS Efficiency)	Сумма весов (Sum of Lambdas)	Эффект масштаба (RTS)	Оптимальные веса (Optimal Lambdas with Benchmarks)
1	Банк 1	1,00000	1,000	Постоянная (Constant)	1,000
2	Банк 2	1,00000	1,000	Постоянная (Constant)	1,000
3	Банк 3	0,47608	1,268	Уменьшение (Decreasing)	0,014
4	Банк 4	0,97290	2,382	Уменьшение (Decreasing)	0,003
5	Банк 5	1,00000	1,000	Постоянная (Constant)	1,000
6	Банк 6	0,83743	1,335	Уменьшение (Decreasing)	0,022
7	Банк 7	0,87106	1,075	Уменьшение (Decreasing)	0,014
8	Банк 8	0,81783	0,448	Увеличение (Increasing)	0,060
9	Банк 9	1,00000	1,000	Постоянная (Constant)	1,000
10	Банк 10	1,00000	1,000	Постоянная (Constant)	1,000

Результаты анализа DEA показывают, что пять из десяти банков достигли эталонного уровня эффективности. Это банки под номером 1, 2, 5, 9 и 10, у которых показатель эффективности равен 1,000. Они используют ресурсы максимально продуктивно и выступают ориентирами для остальных. Для всех них характерна постоянная отдача от масштаба (RTS), что означает стабильную пропорциональность между объемами ресурсов и результатами.

Кроме того, у них сумма весов (λ) равна 1,000, что подтверждает их самодостаточность в качестве эталонных единиц: каждый из этих банков является собственным бенчмарком.

Среди неэффективных объектов наибольшее отставание наблюдается у банка 3, эффективность которого составила всего 0,476. Это означает, что при текущих ресурсах он достигает менее 50 % от возможного уровня. Сумма весов у него равна 1,268, что указывает на ориентацию и на комбинацию других банков. Для него характерна убывающая отдача от масштаба (Decreasing RTS) — при увеличении ресурсов отдача снижается. В практическом плане это значит, что банк переразмерен: его текущая структура фондирования и активов слишком велика, и дополнительные ресурсы используются неэффективно.

Банк № 4 показал эффективность 0,973, что близко к оптимальному уровню. Тем не менее, он не является эталонным. Сумма весов у него составила 2,382, а эффект масштаба также характеризуется как убывающий. Это говорит о том, что банк в целом работает неплохо, но всё же страдает от избыточных ресурсов, что не позволяет ему войти в число лучших практик. Банк 6 № имеет эффективность 0,837, то есть он использует ресурсы примерно на 84 % от возможного уровня. Сумма весов составила 1,335, а отдача от масштаба — убывающая. Аналогичная ситуация у банка № 7 (эффективность 0,871, сумма весов 1,075, также убывающая отдача). Эти показатели говорят о том, что оба банка работают ниже эталонных практик примерно на 13–16 %. Им следует пересмотреть оптимальные размеры бизнеса или повысить отдачу от существующих ресурсов.

Интересным является результат банка № 8. Его эффективность составила 0,818, сумма весов — 0,448, а отдача от масштаба — возрастающая (Increasing RTS). В отличие от банков с убывающей отдачей, банк 8 слишком мал: его ресурсы используются не в полную силу именно из-за недостаточного масштаба. Это значит, что увеличение размеров деятельности (например, за счет расширения кредитного портфеля или роста «депозитной базы») позволит ему повысить эффективность и приблизиться к эталону.

В целом, 50 % банков в выборке оказались на границе эффективности (score = 1,000), тогда как оставшиеся демонстрируют отклонения от 2,7 % (банк 4) до 52,4 % (банк 3). Четыре банка работают с убывающей отдачей от масштаба, что указывает на переразмереность и необходимость оптимизации. Один банк, напротив, имеет возрастающую отдачу от масштаба и должен расширяться.

Таким образом, DEA-анализ не только выделил эффективные и неэффективные банки, но и показал, какие именно стратегии (сокращение либо расширение) могут быть использованы для повышения эффективности.

Высокая эффективность — банки, которые показали максимальную эффективность (1,000) и являются образцовыми в использовании своих ресурсов при постоянном возвращении от масштаба (CRS).

Низкая эффективность — банки, имеющие эффективность ниже 1, могут улучшить свою работу, используя входные ресурсы более эффективно. Данные банки показывают увеличивающиеся возвраты от масштаба, что предполагает, что их эффективность может быть улучшена за счет оптимизации использования ресурсов.

Оптимальные лямбда у банков с низкой эффективностью также показывают низкие значения оптимальных лямбда с бенчмарками, что указывает на то, что они должны стремиться к улучшению своих показателей, используя новейшие практики более эффективных банков.

В целом, анализ показывает, что половина анализируемых банков Республики Беларусь обладают высокой эффективностью, однако некоторые из них требуют улучшений для повышения конкурентоспособности и устойчивости на рынке. На основе этой эффективности следует разрабатывать продукты с учетом имеющихся ресурсов, что в дальнейшем поможет обеспечить высокий ESG-рейтинг.

На основе полученных результатов с применением модели DEA можно сделать следующий вывод: банкам с низкой эффективностью следует провести аудит своих ресурсов и процессов для выявления узких мест, оптимизации затрат и улучшения распределения ресурсов, что позволит привести к повышению эффективности.

Исходя из коэффициента эффективности использования ресурсов можно сделать разбиение по баллам с помощью кластерного анализа всех банков Республики Беларусь (рис.1).

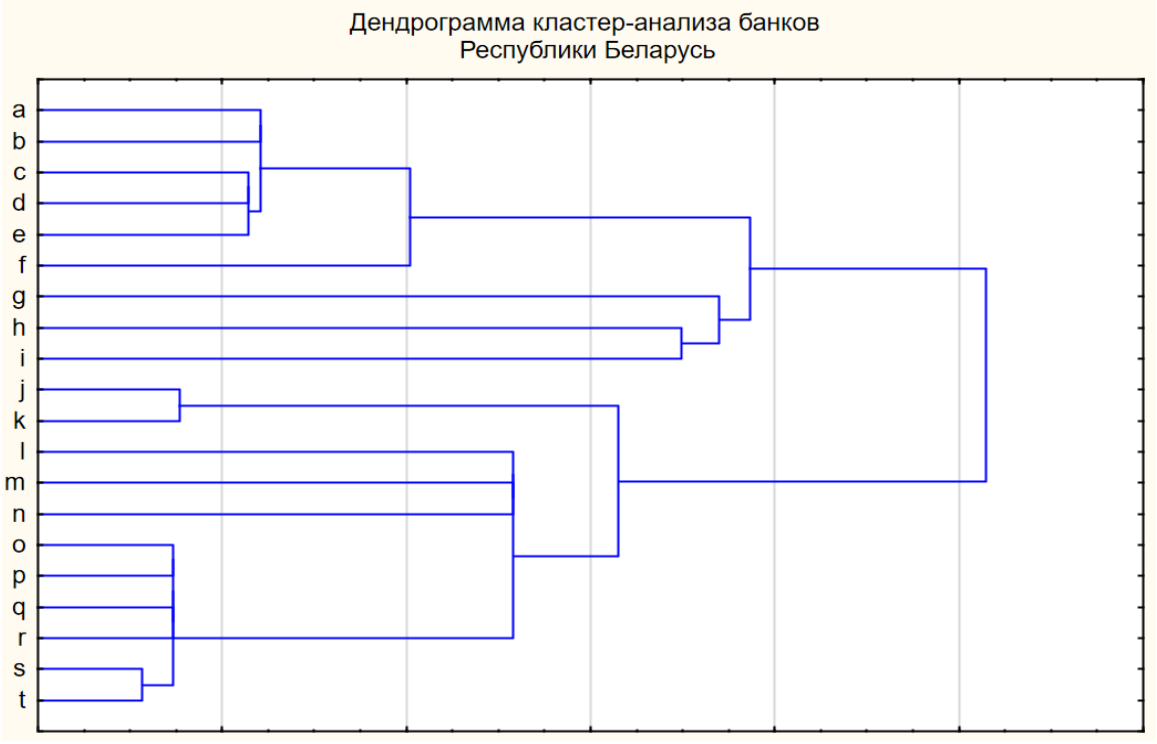

Рис. 1 - Дендрограмма кластер-анализа банков Республики Беларусь

Согласно кластерному анализу банки разбиваются на 10 групп исходя из значения эффективности:

1) эффективность 1,000: высокий ESG-рейтинг (5 баллов);

2) эффективность от 0,900 до 0,999: высокий ESG-рейтинг (4,5 балла);

3) эффективность от 0,800 до 0,899: умеренно высокий ESG-рейтинг (4 балла);

4) эффективность от 0,700 до 0,799: умеренно высокий ESG-рейтинг (3,5 балла);

5) эффективность от 0,600 до 0,699: средний ESG-рейтинг (3 балла);

6) эффективность от 0,500 до 0,599: средний ESG-рейтинг (2,5 балла);

7) эффективность от 0,400 до 0,499: умеренно средний ESG-рейтинг (2 балла);

8) эффективность от 0,300 до 0,399: умеренно средний ESG-рейтинг (1,5 балла);

9) эффективность от 0,200 до 0,299: низкий ESG-рейтинг (1 балла);

10) эффективность от 0,100 до 0,199: низкий ESG-рейтинг (0,5 балла).

Распределение баллов для присвоения ESG-рейтинга на основе указанных критериев эффективности для выбранных нами банков получилось следующее: банки под номером 1, 2, 5, 9 и 10 имеющие эффективность 1,000, получают высокий ESG-рейтинг – 5 баллов, банк № 4, эффективность которого равна 0,97290, согласно шкале – умеренно высокий ESG-рейтинг, однако, он не дотягивает до границы.

Банки № 6-8 получают умеренно высокий рейтинг (0,83743, 0,87106 и 0,81783 соответственно). Банк № 3 – умеренно средний ESG-рейтинг (0,47608).

Таким образом, балл отражает уровень эффективности банков в контексте ESG-стандартов и в дальнейшем выводе дополнительных продуктов.

В последующем следует присвоить рейтинг исходя из критериев таблицы 3 [22, p.3].

Таблица 3

Шкала ESG-рейтингов

Категория	Рейтинговое значение	Описание	Авторская концепция присвоения на основе эффективности	
ESG-AAA	ESG-1 (AAA)	Наивысшая оценка в области экологии, социальной ответственности и управления. Вопросы экологии, социальной ответственности и управления являются приоритетными в деятельности объекта рейтинга.	1,000	5,0 баллов
ESG-AA	ESG-2 (AA+)	Очень высокая оценка в области экологии, социальной ответственности и управления. Вопросам экологии, социальной ответственности и управления уделяется повышенное внимание.	0,900 до 0,999	4,5 балла
	ESG-3 (AA)		0,800 до 0,899	4,0 балла
	ESG-4 (AA-)		0,700 до 0,799	3,5 балла
ESG-A	ESG-5 (A+)	Высокая оценка в области экологии, социальной ответственности и управления. Вопросам экологии, социальной ответственности и управления уделяется достаточное внимание.	0,600 до 0,699	3,0 балла
	ESG-6 (A)		0,500 до 0,599	2,5 балла
	ESG-7 (A-)			
ESG-BBB	ESG-8 (BBB+)	Средняя оценка в области экологии, социальной ответственности и управления. Значительной доле аспектов в области экологии, социальной ответственности и управления уделяется внимание.	0,400 до 0,499	2,0 балла
	ESG-9 (BBB)			
	ESG-10 (BBB-)			
ESG-BB	ESG-11 (BB+)	Приемлемая оценка в области экологии, социальной ответственности и управления. Некоторые вопросы экологического воздействия, социальной ответственности и управления не рассматриваются.	0,300 до 0,399	1,5 балла
	ESG-12 (BB)			
	ESG-13 (BB-)			
ESG-B	ESG-14 (B+)	Низкая оценка в области экологии, социальной ответственности и управления. В отношении вопросов экологии, социальной ответственности и управления нет четко выстроенной стратегии;	0,200 до 0,299	1,0 балл
	ESG-15 (B)			
	ESG-16 (B-)			

		при принятии управленческих решений данные вопросы не учитываются.		
ESG-C	ESG-17 (C)	Очень низкая оценка в области экологии, социальной ответственности и управления. Работа по вопросам экологии, социальной ответственности и управления не ведется.	0,100 до 0,199	0,5 балла

Присвоение ESG-рейтинга должно быть обоснованным. Например, банк, получающий этот рейтинг, должен быть не только эффективным внутри своей структуры, но и учитывать интересы своих клиентов.

Вариант «зеленого» кредитования может стать ключевым инструментом поддержки бизнеса, например, связанного с реализацией экологически чистого транспорта. Компания, занимающаяся продажей электромобилей, может воспользоваться специальной программой финансирования для расширения своей деятельности. Такая программа может включать предоставление кредита на закупку и дистрибуцию электромобилей, развитие зарядной инфраструктуры и расширение сервисных центров. Основные условия кредитования могут предусматривать снижение процентной ставки, например, в диапазоне 7–9% годовых, благодаря государственной поддержке или партнерству с международными экологическими фондами [23, p.2].

В сфере сельского хозяйства (сельскохозяйственные кредиты) банки могут учитывать такие экологические факторы, как устойчивость к климатическим изменениям, что влияет на риски агробизнеса. Поддержка устойчивых методов ведения сельского хозяйства, минимизация воздействия на окружающую среду могут быть важными для получения кредитов [24, p.7].

Присутствует также возможность предоставить «зеленое» кредитование для строительства новых жилых комплексов, поскольку они не только застраивают, используют экологические материалы при отделке, но и облагораживают территорию.

Банки потенциально могут стать важнейшими участниками устойчивого развития, оказывая влияние на распределение средств для «зеленых» инвестиций в здравоохранение, образование, предпринимательство и сокращение бедности [25, p.4].

Построенная модель DEA показывает положительный эффект масштаба, по столбцу RTS можно заметить, что половина банков имеет постоянный показатель, указывающий, что при увеличении всех факторов производства (например, труда и капитала) на определенный процент, выход (или продукция) также увеличивается на тот же процент. В данном случае принимались во внимание выходные показатели, такие как задолженность по кредитам, выданным банками юридическим лицам.

Значительный отрицательный коэффициент на отстающий балл (определяемый по модели DEA) указывает на то, что банки с низкими показателями по ESG-стандартам должны стремится улучшить свои результаты в следующем году.

Данные показатели, демонстрирующие отрицательный коэффициент на отстающий балл, определяемый по модели DEA, свидетельствуют о том, что банки с низкой эффективностью должны не просто «улучшать результаты в целом», а целенаправленно повышать эффективность использования ключевых ресурсов. Речь идёт об оптимизации структуры депозитной базы, снижении стоимости привлечённых обязательств, а также повышении отдачи от кредитного портфеля — как корпоративного, так и розничного. Эти изменения напрямую влияют на экономическую составляющую ESG, усиливают устойчивость финансовых потоков и создают предпосылки для дальнейшего повышения экологических и социальных показателей. Из этого следует, именно конкретные количественные параметры — эффективность управления, депозитами и кредитами — становятся ориентирами для банков, стремящихся укрепить свой ESG-рейтинг.

Нелинейность переменных модели, наблюдаемая во взаимосвязи между показателями для ESG-рейтинга, обычно исчезает. Тем не менее, остальные контрольные переменные сохраняют свою значимость и влияние, которое остается как высоко значимым, так и отрицательным.

ESG-повестку следует не только развивать, но и активно внедрять в практику, поскольку достижение Целей устойчивого развития требует интеграции принципов устойчивого развития во все сферы деятельности и активных действий. Реализация ESG-инициатив способствует не только улучшению экологической ситуации, но и социальному прогрессу и эффективному управлению. Это, в свою очередь, может привести к повышению устойчивости бизнеса, привлечению инвестиций и улучшению репутации на международной арене. Активное применение ESG-принципов помогает создать более справедливое и устойчивое общество, что является ключевым аспектом для достижения долгосрочного успеха.

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HISTORICAL SCIENCES

THE CONCEPT, FUNCTIONS, AND HISTORICAL SIGNIFICANCE OF THE PROVINCIAL AND LOCAL PRESS THE PRESS AS A HISTORICAL SOURCE

Zakkar A.
PhD student,
University of Debrecen, Doctoral School of History and Ethnology
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Abstract

This study explores the concept, functions, and historical significance of the provincial and local press in Hungary during the early twentieth century. It distinguishes the often-conflated categories of "provincial" and "local" press and demonstrates their differing social, spatial, and political roles. Despite structural weaknesses- economic vulnerability, limited editorial capacity, and political influence- provincial and local newspapers played a crucial role in shaping local public life, forming community identity, and mediating public opinion. The chapter argues that the local press functioned not only as an information medium but as an integral component of local society. It also outlines the methodological framework for using local newspapers as historical sources.

Keywords: local press; provincial press; public sphere; public opinion; Hungarian press history; Debrecen; interwar period; media and society

I. Introduction

The history of the local and provincial press represents a field of Hungarian press history that has so far been only partially explored. While the press of the capital -owing to its political, cultural, and economic importance- became an early focus of historical scholarship, provincial and local newspapers remained marginalized for a long time.[2] This neglect is particularly striking given that, in the decades following World War I, a substantial proportion of Hungary's periodical publications were produced in provincial regions, where they played a decisive role in the everyday flow of information, the formation of local identity, and the political socialization of local communities.

The aim of this chapter is to establish the theoretical, historiographical, and methodological foundations for the central inquiry of the dissertation, which undertakes a detailed historical analysis of the local daily newspaper Debreczen. Its core question concerns how the concept of the local press can be interpreted in the context of Hungary in the first half of the twentieth century, what social, political, and cultural functions it fulfilled, and how -and to what extent- it can be employed as a historical source. Accordingly, the chapter is not merely descriptive; it adopts a problem-oriented perspective, examining how the local press mediated social relations, the degree to which it shaped public opinion, and the ways in which it was embedded within the structure of the public sphere.

One of the conceptual problems is the distinction between the provincial and local press. In the literature, these two categories are often – incorrectly – presented as synonyms, despite the fact that there are significant differences between them in terms of their function, scope, and social embeddedness. The study starts from the basic thesis that all local press products can be considered provincial press, but not all newspapers published in provincial areas can be classified as local press. This distinction is not merely a question of terminology, but also fundamentally determines how the social functions and historical significance of a given press outlet can be interpreted.

The aim is also to show the structural and social conditions under which provincial newspapers gained ground in Hungary, with particular reference to the first decades of the 20th century. The study examines the division of roles between the capital and the provincial press, focusing on the fact that while Budapest, the capital, functioned primarily as a center of cultural, scientific, and official public spheres, the provinces became the primary arena for political and local public discourse.[3] A key aspect of the analysis is the examination of the structural weaknesses of the provincial press, highlighting the economic, organizational, and personnel factors that determined the operation of local newspapers: limited financial resources, a *"one-man"* editorial structure, and political and economic dependencies.

[2] This situation was further reinforced by the fact that at the turn of the nineteenth and twentieth centuries the press experienced not only a formal and qualitative transformation, but also a quantitative explosion. As a result, research into the history of the press-both provincial and national-was interrupted at a certain point. The sheer volume of material would have required not only extensive time and labour, but also considerable financial resources. The second (and to date final) volume of the academic series was published in 1985, covering the history of the Hungarian press between 1867 and 1892. The editor-in-chief of the work was Miklós Szabolcsi, and the editorial team included such distinguished scholars as Domokos Kosáry, Géza Buzinkay, Tibor Erényi, and András Gergely. See: Ágnes Széchenyi, The Missing History of the Hungarian Press in the Twentieth Century – Debt List and Proposal, Magyar Tudomány, 2004/10, p. 1150.

[3] Understanding this duality is essential in order to understand the operation of the Debreczen newspaper not merely as a local phenomenon, but as part of the national press structure.

Another important issue is the relationship between local society and the press. The local press cannot be understood merely as a means of conveying information: its operation is closely intertwined with the social environment, which is why the concept of local society is introduced as a category of analysis, examining how the press conveyed local identity, traditions, values, and conflicts. The chapter concludes with a discussion of the power of the press, with particular emphasis on the concepts of public opinion, the audience, and the public sphere. How did the local public sphere develop, how was public opinion formed, and what role did the press play in this as a mediating and interpreting institution? At the same time, it also addresses criticism of the press, particularly the issue of business and political influence, as well as the problems of restrictions on press freedom.

II. The rise of provincial newspapers[4]

In Hungary, a significant proportion of the periodical press, more than half, was published in provincial areas, despite the fact that provincial newspapers often operated under less favorable financial conditions. Nevertheless, the provincial press remained a significant competitor to the capital's newspapers, and some provincial newspapers even had significant social and political influence. **From the moment Budapest became the capital,** the provincial press can be discussed in a modern sense. The first period, which lasted until the 1880s, can be considered the initial stage of provincial journalism, which we refer to *as the* "*the formative period of provincial journalism.*" The second phase, which began in the 80's, was *the Middle Ages* of the provincial press, which was also the consolidation of the provincial press. During this period, an increasing number of printing houses were established, and a number of influential provincial newspapers emerged, especially in Arad, Oradea, Cluj-Napoca, Bratislava, Szeged, and Debrecen.[5] In 1894, 18 daily newspapers were published in provincial areas, while in Budapest, the number of daily newspapers was only 15. The presence of the provincial political press was further strengthened by 54 political weeklies, which were usually published once a week, and in some cases three times a week. The number of non-political social weekly newspapers in the countryside during the same period was approximately 162, which clearly indicates the demand for press products with social themes, while trade journals did not have national significance in the countryside. The most significant group of provincial periodicals was religious and church magazines: 82 of these were published, many of which were distributed nationwide. The third phase, the "*modern era*," can be placed in the post-World War I period. The First World War caused significant losses in the Hungarian periodical press: in 1914, nearly a thousand press outlets ceased operations. However, this decline primarily affected the press in the capital, while provincial newspapers outnumbered those in Budapest, leading to a restructuring of the domestic press. The war brought a clear upswing for the provincial press.[6] Provincial newspapers, which had previously focused primarily on local events and curiosities, began to place greater emphasis on news from the capital, which significantly increased reader interest.[7]

As a result, the composition of the newspaper-reading public also changed: social groups that had previously shown no interest in the press became regular readers. After overcoming problems related to paper supply, technological advances not only increased circulation, but also made it possible to reduce prices, so

[4] The term "provincial" can be used in several ways. On the one hand, it may denote a simple geographical distinction-namely, everything that is not Budapest. On the other hand, however, it also carries a much broader and more complex meaning: it can refer to patterns of thought, behavior, and lifestyle that reflect the cultural character of a given community. "Provincial" therefore denotes a particular quality of life and mindset which, in modern approaches, may even be interpreted as a specific behavioral model. See: Pál Bánlaky, The Symptoms of Provinciality, Békéscsaba, 1989, p. 5. According to the Minister of Culture, Count Kuno Klebelsberg, the term "provincial" had undeservedly acquired a pejorative meaning. In his view, those who spend considerable time in the countryside can encounter cultural values that are not always accessible within certain circles in Budapest. Délmagyarország, January 20, 1931, p. 2.

[5] The emergence of proposals for church policy reforms also contributed to the development of the provincial press. In response to these reforms, Catholic newspapers were founded-initially in episcopal seats and later in several larger cities-with the aim of opposing the government's church policy initiatives. In 1890, a total of 687 newspapers were published in the Hungarian Empire, and six years later this number had nearly doubled to 1,203. These newspapers appeared not only in Hungarian but also in the languages of all nationalities living within the empire. See: Cs. L., The Provincial Press, in: Press. Scientific Journal of Journalism, 1927, no. 7, p. 1.

[6] With the outbreak of the war, the situation of provincial daily newspapers changed significantly. Editors sought to obtain as much up-to-date information as possible from Budapest, a process facilitated by the government's official press agencies. As a result, provincial newspapers regularly received official reports from the battlefield, along with other important announcements, which greatly contributed to the boom in the provincial press. Through local newspapers, provincial readers were able to learn about war events 12–24 hours earlier, as national newspapers often reached provincial areas with considerable delay due to transportation difficulties. Thus, the local press became the primary source of information through which the population of the provinces could access news most rapidly. Cs. L., 1927, issue 7, p. 2.

[7] According to the 1900 census, Debrecen had a population of 75,006, a figure that increased substantially over the following decade. By 1910, the city's population had risen to 92,729, indicating a clear trend of dynamic growth. The linguistic homogeneity of the settlement remained unchanged: the number of native Hungarian speakers reached 91,305, representing 98.5% of the total population. Knowledge of the Hungarian language was almost universal, with 92,236 people (99.5%) able to speak Hungarian. Data from the last census before the Great War show that 72.3% of the population (67,358 people) were literate-well above the national average of 58.2%. Rovács Barna, Ady Endre's Academic Career in Statistics – With the Help of Contemporary Thematic Maps, in: Book and Education, 2019/3–4.

that cheap newspapers were no longer available only to the elite, but also to the masses.[8]

This growth in readership primarily benefited provincial newspapers, strengthening their role in the Hungarian press market.[9] According to the 1920 census, a total of 79,765 people in Debrecen were literate. The distribution of literacy rates varied according to age. Among the 6–11 age group, 9,571 people were literate, among the 12–14 age group, 6,343 people were literate, while among the 15–19 age group, 10,350 people were literate. The number of literate people was 18,431 among those aged 20–29, 13,554 among those aged 30–39, and 9,232 among those aged 40–49. Among those aged 50–59, 6,828 people were literate, among those aged 60–69, 3,922 people were literate, while among those aged 70–79, 1,304 people were literate. Among those aged 80 and above, the number of literate people was 1,534.[10] According to data from the 1930 census, the population of Debrecen over the age of six was 104,268, of whom 96,069 could already read and write, meaning that 92% of those over the age of six were literate.[11]

The educational reform process that began in the early 1920s also contributed greatly to the growth of the reading base. Kuno Klebelsberg's work was of decisive importance in this regard: he made advances in the development of education that had a direct impact on the level of literacy and the increase in the proportion of people who could read and write. While in 1910 the illiteracy rate among the population over the age of six was 33% nationwide, by 1920 this figure had fallen to 15% and by the 1930s it had fallen even further.[12] A major wave of educational reforms began in 1926 with the launch of a comprehensive development program. As part of the program, 3,500 new classrooms and 1,750 teachers' apartments were completed, and 1,096 new elementary schools were established between 1926 and 1931. In provincial areas, educational progress among the lower social strata unfolded at a somewhat different pace, with folk high schools (adult education institutions) assuming a key role in facilitating the educational catch-up of rural and peripheral communities.[13] These measures contributed greatly to the expansion of the press readership.[14]

Parallel to the expansion of the readership, readers' demands also gradually increased, their tastes developed, and they increasingly expected high-quality press products. As a result, the editorial and content quality of provincial newspapers also improved.[15] The most significant editorial offices of the era operated in Miskolc, while most newspapers were published in Debrecen, where 19 different newspapers were published, collectively distributed across 115 cities and towns.[16]

III. The division of roles between the capital and the provincial press

Provincial newspapers often drew on material from evening newspapers arriving from Budapest, sometimes copying articles verbatim, which often represented a higher standard of editing and content.[17] The provincial press grew steadily in numbers, although at a moderate pace: by the beginning of 1926, there were already 316 provincial newspapers in operation, and this number increased during the year, indicating the expansion and stabilization of the provincial press.

We have accurate data from early 1928 on how the periodicals developed, which clearly shows the structural differences between the capital and the provinces. While Budapest functioned as the primary center of cultural, scientific, and official public discourse, the provinces primarily provided a forum for political and public life. Budapest's dominance is striking in the category of daily newspapers: news-reporting dailies were published exclusively in the capital, and the number of political dailies was also significant (22). At the same time, the countryside was strongly represented in this category, with 46 political daily newspapers, which

[8] Bajomi-Péter Lázár, Media and Society, Budapest, 2008, p. 26.

[9] This expanding readership primarily benefited provincial newspapers, as clearly demonstrated by contemporary statistical data. While in 1913 the 38 daily newspapers published in Budapest distributed a total of 204.8 million copies via post and rail, by 1920 this number had dropped dramatically to 95.8 million. This decline weakened the position of the capital's press, whereas the circulation and readership of provincial newspapers grew significantly. Cs. L., 1927, no. 7, p. 3.

[10] Hungarian Royal Central Statistical Office. The 1920 Census. Literacy by Native Language and Age. Budapest, 1928, pp. 234–235.

[11] Hungarian Royal Central Statistical Office. The 1930 census. The literacy of the population. Budapest, 1932. 29.

[12] One of the decisive stages in this development was the confirmation in 1921 of compulsory school attendance for children between the ages of 6 and 15 (Act XXX). Ignác Romsics, History of Hungary in the 20th Century, Budapest, 2002, p. 175.

[13] These institutions contributed to the improvement of the general education of the population through courses lasting several weeks or months, and played an important role in the cultural advancement of society. Romsics (2002), p. 178.

[14] Between the two world wars, interest in literature also increased significantly. A large portion of the petty bourgeoisie, as well as an ever-growing number of organized workers, developed a strong interest in reading. As a result, the number of books published did not decline; on the contrary, it rose steadily. While 2,378 volumes were published in 1913, by 1934 the number of different books published in Hungary had reached 3,920. This boom was interrupted by the paper shortage of 1938–1939 and by the introduction of the First Jewish Law, both of which significantly hindered the development of book publishing and intellectual life. Romsics (2002), p. 211.

[15] The improvement in the quality of the press was also facilitated by the fact that editorial offices increasingly employed highly competent staff. Journalists collected information quickly and thoroughly, both locally and from Budapest. They processed news arriving by telegraph, telephone, and radio with professional skill. Most provincial editorial offices already possessed radios, which enabled editors to learn about events across the country-and even around the world-almost immediately. Information obtained in this way passed rapidly through local editorial offices and could appear in the columns of newspapers shortly thereafter. Cs. L., 1927, issue 7, pp. 1–6.

[16] Cs. L. 1927, issue 7, pp. 1-6.

[17] In addition, some provincial daily newspapers received fresh reports from the capital by telephone or telegram, thus ensuring that readers had quick access to national events.

shows that local political life and the provision of information to regional communities played a decisive role in the countryside. In terms of weekly newspapers and magazines, the countryside clearly dominated: more than two-thirds of political weekly newspapers and magazines were published in provincial areas (122 out of 168), and a similar trend can be observed in the case of newspapers published three times a week: 144 provincial newspapers were published, while Budapest published only 46 such publications.[18]

Overall, 699 newspapers were published regularly in Budapest, while 361 were published in the countryside, which is almost twice as many as in the capital. At the same time, the number of publications alone does not reflect the difference in the functional role of the press, which thus had a dual character: the capital's press served as a forum for the discourse of the national elite, while the provincial press continued to function as a venue for identity formation and political communication in local societies.

IV. Structural weaknesses of provincial newspapers

Provincial newspapers had to contend with a number of difficulties. One of the most significant was chronic financial constraint: the owner, founder, publisher, or financial backer of a paper often carried out the editorial work as well, meaning that professional, trained journalists were seldom employed.[19] The second difficulty likewise stemmed from this situation: the editors of such *"one-man"* weekly newspapers could not adopt a fully independent position, either financially or intellectually. They were obliged to consider a wide range of constraints and expectations, which often came at the expense of their editorial work. They had to take into account the interests of the publisher or printer, the wishes of local officials, and the demands of their readership.

For provincial weekly newspapers to employ professional journalists and editors, it was essential first to overcome their financial difficulties.[20] The objective was to employ only those staff members for whom the newspaper could provide a secure and respectable livelihood. Achieving this required the accumulation of sufficient capital, a process in which the establishment of an in-house printing press constituted a crucial step.[21] The core objective at the time can thus be summarized as follows: *"it should not be the printing house that owns a newspaper, but the newspaper that possesses its own printing house."* In addition to lowering printing costs, expanding the subscriber base and attracting new advertisers generated further revenue. Taken together, these income sources created the financial foundation that enabled the provincial press to professionalize and to operate sustainably in the long term.[22] Once these objectives had been met, it became evident that the provincial press was also capable of providing a stable and secure livelihood for professional journalists.[23]

Another significant problem was the absence of organizational cohesion within the provincial press. Provincial newspapers lacked a unified, structured body that could effectively represent the economic and social interests of their members or maintain systematic communication between individual publishers and editorial offices. This organizational vacuum generated persistent difficulties, and it became increasingly evident that the only viable way to improve the situation

[18] The capital's dominance in the field of cultural and professional journalism was unequivocal. The vast majority of literary, critical, fashion, and other cultural periodicals were published in Budapest (113 out of 151), and the capital also maintained an almost complete monopoly in the category of scientific journals: 88 of the 94 scientific periodicals were produced there. Official newspapers were likewise concentrated in the capital, owing to its central administrative role. By contrast, the distribution of religious newspapers was considerably more balanced: 40 were published in the capital and 42 in the provinces, indicating that religious life was structurally and institutionally deeply rooted in provincial society. Statistics on the press in truncated Hungary. In: A Sajtó, Scientific Journal on the Press, 1929, no. 2, p. 77.

[19] Not only was the lack of trained journalists a problem, but it was also uncertain whether a professional journalist, once hired by a provincial newspaper, could earn a decent living. Owing to the limited financial resources of provincial editorial offices, a journalistic career in the provinces often meant economic insecurity and frequently led to livelihood difficulties. Géza Buzinkay, "The Career of a Journalist." In: Tibor Malkovics, Press and Media History. Budapest, 2003, p. 151.

[20] The profession of journalism developed through several stages. First, journalism became distinct from other occupations and emerged as an independent field of work. This was followed by the growing demand for specialized knowledge, which initiated the process of professionalization. The third stage was characterized by a decline in external political, economic, and institutional interference, which enabled the strengthening of journalistic autonomy. Finally, a form of collective professional identity emerged among journalists, accompanied by the development of an individual social identity that already displayed the features of a professional community. Svennik Høyer – Epp Lauk, "Professional Journalism and Civil Society. A Historical Overview." Jel-Kép, 1995/1, p. 77.

[21] Not only was the establishment of printing presses significant, but the substantial technological development in printing at the beginning of the century-both in the provinces and in the capital-also played a crucial role. This period marked the beginning of the so-called vertical integration of publishing houses and printing companies. Dezsényi Béla – Nemes György, 250 Years of the Hungarian Press, Vol. I. Budapest, 1954, p. 222;

[22] László Tarr, On Provincial Weekly Newspapers. In: The Press, Scientific Journal of Journalism, 1933, No. 10, p. 257.

[23] In summary, at the beginning of the 20th century, the "typical" professional journalist almost invariably worked for a nationally distributed daily newspaper: they produced news, wrote reports, and participated in the editing of individual columns. Their activities were documented by official certificates, and their income generally enabled them to maintain a middle-class standard of living. Another important characteristic was their membership in the Journalists' Pension Fund, which represented a fundamental form of professional security and existential stability. Since the modern press was concentrated mainly in the capital, the majority of professional journalists were also members of the Budapest Journalists' Association. Balázs Sipos, Personal Sources and the Narrative of Historical Experience. Individuals and Communities in Hungary 1848–1948, p. 107–108.

of the provincial press was the creation of a unified institutional framework.[24] This problem was ultimately addressed by Gyula Szigethy, the owner of Debreczen. He established the Provincial Press Syndicate, which soon evolved into a large-scale organization and eventually gave rise to the Economic Association of Provincial Daily Newspapers. This institution played a decisive role in alleviating the structural problems of the provincial press.[25]

V. All local press can be regarded as part of the provincial press, yet not all provincial newspapers qualify as local.

Definition and operational characteristics of the local press

The concepts of provincial press and local press are frequently conflated, yet they can be clearly differentiated both in terms of content and geographic scope. The provincial press denotes publications issued outside the capital that cover a broader territorial area, including newspapers published in major provincial towns which reported on public, political, and cultural developments across an entire region, a county, or even multiple counties. County daily newspapers are typical examples, as they disseminated news not only about a single settlement, but about a wider surrounding area as well. By contrast, the local press concentrated on a single municipality or a smaller spatial unit. These newspapers focused primarily on local public life, economic matters, and cultural and social events, and their readership was therefore generally confined to one specific city, town, or community.[26]

The local press must be examined both as a historical phenomenon and as a historical source. Only through a coordinated and systematic analysis can a comprehensive understanding be gained of its development, its values, and its role in social life. In Hungarian press historiography, this field has remained largely underexplored, and several problem areas -many of them specific to local press research -continue to be insufficiently studied.[27] Since the concept of the local press has not yet been sufficiently clarified in the scholarly literature, it is necessary to define both *"local"* and *"press"* more precisely and unambiguously in order to render the term professionally coherent and analytically usable.[28]

The press is a distinct medium of social communication, characterized by a variety of forms and modes of content.[29] These characteristics have changed repeatedly throughout history, and therefore the concept cannot be defined in a single, fixed manner. To examine the press with sufficient rigor, the term itself must first be clarified: what do we mean by *"press"*? The very word newspaper implies the communication of new events and information of interest to wider segments of society, making its printed dissemination both necessary and justified. The earliest forms of the press appeared as leaflets reporting primarily on battles and other major events. In its modern form, however, the press functions as a means of providing the public with continuous and regular information- a need generated by civil society with the intention of informing and serving the broader public as comprehensively as possible.[30]

As a social phenomenon, journalism has continually adapted to historical processes, which in turn have shaped its development.[31] It consistently reflects the social transformations within which it has evolved, enabling its historical and social origins to be identified with considerable precision. Its development and functioning have been shaped by a wide range of external influences, including bureaucratic intervention, the technological and market conditions of press production, journalistic practices, and prevailing ethical and professional standards. Northcliffe, the English newspaper publisher, was the first to recognise a new form of modern journalism: the mass-circulation, information-centred newspaper. He argued that the general public was not interested in abstract or overly general issues, but rather sought topics that were personally relevant, romantic in tone, or connected to sport and everyday life. Even major political events captured the

[24] "It is a remarkable and incomprehensible phenomenon in Hungary that neither law nor customary law provides protection or safeguards the livelihood of journalists." Rezső Péchy-Horváth, cited in László Tarr, "On Provincial Weekly Newspapers," A Sajtó. Scientific Journal of Journalism, October 1933, p. 257.

[25] József Pálfy, The Directors of the Newspaper Company. DEENK Kassai út Campus Manuscript Archive, compiled by József Pálfy, Ms 11/1:4 2.

[26] For example, a small-town or district weekly or daily newspaper can be regarded as part of the local press.

[27] Gáborné Korompai, History and Literature of Press Research in Debrecen. Debrecen, 1979, p. 69.

[28] Miklós Bényei, The Printed Messengers of the Civic Spirit. Debrecen, 2007, p. 243; Mihály Szívós, "Regional Innovation and the Revaluation of Local Publicity," in Space and Society, Vol. XXIV, 2010, p. 51.

[29] At the beginning of the 20th century, the press and radio were among the most important means through which people could learn about a world they had not experienced firsthand. Although other media also contributed to shaping the public's worldview, the press played an especially decisive role in expanding people's horizons. It enabled readers to become acquainted with events, places, and social phenomena beyond their personal experience, thus serving as a fundamental instrument for representing reality and disseminating information. Balázs Sipos, Press and Power in the Horthy Era. Budapest, 2011, p. 74.

[30] József Halasy-Nagy – Can newspapers educate the public? In: A Sajtó, Scientific Journal of Journalism, 1934. Issue 5-6. p. 2.

[31] According to university professor József Halasy-Nagy, journalism is fundamentally driven by two core motives: the service of political and economic interests. In his view, journalistic activity was organized around these two objectives; therefore, when analyzing a press product, one must primarily examine which pieces of information were made public and which were left unsaid. It is well known that a given piece of news can be written in several different ways: while two articles may be identical in terms of factual content and both may accurately reflect reality, the mode of presentation can significantly influence the reader's interpretation. Thus, journalism was not merely a vehicle for transmitting information but also a tool for shaping interpretive frameworks. Halasy-Nagy (1934), pp. 1–4.

public's attention only when they bore some direct personal relevance.[32]

The term press is used today by professionals in both a narrow and a broad sense, yet it is essential to emphasise that any press publication must meet four fundamental criteria: it must be produced in a reproducible form, appear at regular intervals, contain current information, and be intended for a public audience. When considering the conceptual scope of the press, newspapers and magazines constitute its most narrowly defined category, whereas calendars, yearbooks, school newsletters, almanacs, and annually or biennially issued pocket books occupy a borderline position.[33]

The other component of the concept- the adjective local -indicates that the content of the press product is primarily connected to a specific place, such as a county, district, town, municipality, or, in some cases, a particular institution. Its principal function is to inform those who live or work within that area, and its articles typically contain information of explicit local relevance.[34]

The most appropriate point of comparison for the local press is the national press; however, the local press cannot be equated with the provincial press. There are local newspapers published in the capital that target narrowly defined audiences- such as workplace communities, schools, or residents of particular districts - and therefore address only the population of Budapest. Conversely, a considerable number of newspapers published in provincial areas can be regarded as national in character, both in terms of their content and their distribution.[35] The boundaries between the national and local press are often indistinct, particularly in the case of so-called regional newspapers, whose circulation and influence may extend across sizeable parts of a country or specific regions.[36]

Over time, and in response to changing societal demands, a wide variety of local press formats emerged, which continue to display considerable diversity in both content and form. Among the most prominent types were political newspapers, county and municipal daily papers, as well as weekly newspapers published in towns and larger urban centres.[37] Although several categories can be distinguished, in practice a single publication may simultaneously fall into more than one of them. Content overlaps are frequent, meaning that a substantial proportion of press products cannot be classified as *"pure"* types. Local newspapers played a particularly prominent role in the dissemination of culture: they contributed to the expansion of general education, the strengthening of moral standards, and the shaping of public taste. Their informative notices, literary texts, critical reviews, and illustrations all served these cultural functions. The local press also offered extensive opportunities for writers, artists, researchers, and for students and intellectuals engaged in literary, artistic, or scientific work. Newspapers provided a platform through which these individuals could articulate and disseminate their ideas.[38] The phenomenon of overlap frequently arises from the diverse functions and tasks that these newspapers perform. Local papers regularly reported on national and international political developments, often supplementing these with analysis and commentary. In addition, they provided coverage of economic, legal, cultural, religious, and various other topics, resulting in an exceptionally diverse and wide-ranging content profile.[39]

At the beginning of the twentieth century, the local press played a decisive role in shaping cultural, political, and economic life. Although the quality of these newspapers was often uneven, this inconsistency was frequently compensated for by the sheer number of titles in circulation. Consequently, despite variations in editorial and stylistic standards, readership levels remained remarkably high. Local newspapers reached social groups that the national press was unable to address, and for many individuals they served as the primary- indeed, at times the only- source of information.

[32] The newspapers edited by him - most notably the Daily Mail - followed new editorial principles: the paper's columns were filled with everyday events presented in the most sensational manner possible. It covered topics that had previously been ignored by the press, such as job opportunities and childcare issues. The Daily Mail sold millions of copies, with a substantial share of its revenue coming from advertising. Northcliffe also recognized that mass-market newspapers could only achieve high circulation if their content did not exceed a certain intellectual level and if articles were written in clear, accessible language tailored to the tastes of the masses. He believed that a newspaper publishing overly sophisticated or bourgeois texts could never reach as broad a readership as one written in an easily understandable style and focusing on popular topics. Halasy-Nagy (1934), pp. 1–4.

[33]The classification of occasional publications that appeared in newspaper format remains a debated issue in press history scholarship. Nevertheless, it is clear that press products which appeared periodically but produced only a single issue-due to financial constraints or legal prohibitions, for example-must still be considered press products. Bényei (2007), p. 245.

[34] The "local" character of a newspaper means that the publisher intended it to be distributed exclusively within a clearly defined and delimited area. Consequently, national distribution and recognition were of secondary importance. The local press is never identical with the provincial press, since even in the capital there existed local newspapers intended for a specific, narrowly defined readership. Bényei (2007), p. 244.

[35] Examples of this phenomenon include national literary journals. In the second half of the 1920s, versatile and vibrant newspapers reappeared, once again serving the aims of what contemporaries called "qualified destruction." Kókay György – Buzinkay Géza – Murányi Gábor, A magyar sajtó története (The History of the Hungarian Press). Budapest, 1994, p. 192.

[36] Ibid. pp. 244-245.

[37] Further examples include movement newspapers, economic newspapers, professional journals, as well as church, school, and university publications. Moreover, information and advertising papers, sports newspapers, company newspapers, and scientific journals can also be classified here. Bényei (2007), p. 246.

[38] The work of many prominent poets, writers, and scholars began in these newspapers, and many other high-quality works were also published there. ibid. p. 246.

[39] Bényei (2007) p.245.

As a result, they managed to attract a broad and diverse readership even when their content quality fluctuated.[40]

A recurring criticism held that the language employed by the press contributed to the erosion of linguistic norms. However, the reality was considerably more nuanced. The nature of journalistic work -whether in the capital or in provincial editorial offices -required constant alertness, rapid response, and the swiftest possible reporting of daily events.[41] The competitive nature of the press market made it impossible for daily newspapers to report events with a delay of even a few days. Although the public clearly prioritized the rapid delivery of news, the speed of information flow at times came at the expense of linguistic refinement.[42] Articles increasingly contained ungrammatical constructions and overly simplistic formulations of ideas. These erroneous or linguistically undemanding turns of phrase entered the press through newspaper writers and gradually *"filtered into"* the pages of the newspapers as well.[43]

VI. The concept and significance of local society in press history research

The construction of an image of local society is of interest not only to specialists, but also to citizens who seek self-understanding and wish to define their place within the community. Local society can be examined from multiple perspectives: agricultural experts may approach it through the lens of household or backyard farming; historians through local historical research; economists by focusing on economic processes; and ecologists from the standpoint of environmental protection and regional ecological movements. Regardless of the perspective applied, it is clear that local societies are not merely theoretical constructs but diverse forms of social organization that function effectively in everyday life.[44]

"I define local society as a meso-group formed in a given settlement, which mediates interests, values, and ideologies between the individual and society as a whole through primary groups, preserves traditions, and enables locally rooted (autochthonous) self-organization."[45] In Antal Bőhm's interpretation, local society should be understood as a relative unit, system, or subsystem. Its defining characteristic is that it performs a mediating function that facilitates the integration of individuals into a broader social group. This presupposes that local societies mediate between different levels of the social structure, and that the local press not only records and reports local events but also actively participates in shaping the norms and articulating the conflicts of local society.

According to another interpretation, when viewed from the perspective of a settlement, the concept of local society primarily refers to a spatially defined dimension, forming a distinct community that can be clearly delimited within a specific area. It is therefore crucial to examine the extent to which the qualitative composition of this local community influences the emergence and functioning of the local press. For the various roles within a local community to be effectively fulfilled, a well-integrated social structure is indispensable.[46] Moreover, the local community must also function as a cultural mediator, which is essential for understanding and navigating the natural processes of everyday life.

If we define local society according to the strictest criteria, several aspects must be taken into account: a local society constitutes a clearly delineated spatial unit with a geographically defined and relatively stable population. This community is held together by a network of interpersonal relationships and possesses a shared history that has shaped its local traditions and customs. Its members share a common identity framework, expressing feelings of belonging and attachment-such as local patriotism and regional identity.[47]

There are several essential components of mediated culture. Among these, the elements of material culture -those transmitted and maintained by the local community -are particularly significant. One illustrative example is the built environment, which clearly reflects the distinctive characteristics of local culture.[48] Two significant components of behavioral culture are relational forms and work culture. Relational forms refer to the patterns of everyday interaction and social

[40] Ibid. p. 246.

[41] "News is not what has happened, but what is happening." Balázs Géza- Szayly József- Szilágyi Árpád- Media Studies. Budapest, 2005. p.24.

[42] Zsolt Harsányi, The Hungarian Nature of the Press. In: The Press, Scientific Journal of Journalism, 1930, issue 6, p. 289.

[43] It is important to emphasize that although the press is often accused of corrupting the Hungarian language, it can also exert a corrective influence. Jenő Rákosi, for example, made a significant contribution to preserving the purity of the Hungarian language through his language-cultivation activities in the press. Ibid., p. 290.

[44] András Gergely, Urbanized Beehive, or Local Society Budapest, 1993, p. 7.

[45] Antal Bőhm's interpretation of local society, cited in Pál Bánlaky, Local Society III. Structural Relations in Local Society, p. 15.

[46] The quality of local society was significantly influenced by the extent to which the individuals constituting it were able to form a genuine community. It was essential that a well-integrated social structure emerge, one capable of ensuring the smooth functioning of everyday life. (Pál Bánlaky, Local Society as a Medium of Cultural Mediation, in: Still from the Sidelines: New Essays and Studies (1995–2019), Budapest, 2020, p. 11.

[47] Ibid. p.13.

[48] Characteristic features included residential buildings, the appearance of streets, and even the flowers and plants cultivated in gardens, all of which were shaped by local fashions. Another important group was the world of interior furnishings: furniture, household items, and decorative objects, which not only carried ethnographic markers but also reflected social status and its associated expectations. This phenomenon extended to everyday objects as well. Such items spread from family to family, became fashionable, and eventually became commonplace: if a few wealthy families hung paintings on the walls when building new houses, the habit quickly spread, and soon a painting appeared in the home of every "respectable" family. Clothing and related customs also constitute significant cultural elements within local societies. These were not expressed solely in folk costumes-although for ethnographers, traditional dress remains the most visible and most frequently analysed manifestation. Bánlaky (2020), pp. 16–17.

conduct between individuals, which are shaped by the strong normative framework of local society. These include, for instance, customary forms of greeting and modes of address. Work culture likewise represents a complex domain in which the practices and expectations associated with labour are regulated according to local societal norms. Each local society develops its own standards that dictate how particular tasks should be performed and what is regarded as appropriate or acceptable.[49]

Between the two World Wars, Debrecen-the so-called cívis (civic/bourgeois) city-was, alongside Szeged, the largest urban centre in Hungary outside the capital. Its society exhibited a distinctly European, bourgeois character. At the same time, beyond the urban core, the surrounding areas retained the features of a small town or village, and in the more remote outskirts even resembled farmstead-like rural settlements rather than a major city.[50] We must take into account both the duality inherent in the city's specific functions and the broader relational networks that shaped the urban space available to its inhabitants.[51] Three pillars define a city: *"spatial extent, demographic embodiment, and functional role."*[52]

Political culture was likewise a significant component of every local society. Its development was closely tied to the degree to which citizens were able to articulate their views and exert influence on their surroundings. Equally decisive were the arenas and forms through which public opinion could be expressed, shaped, and negotiated, as these fundamentally structured political discourse and public life.[53] Political discourse unfolded primarily in political newspapers. In 1926, for instance, 203 such papers were in circulation, 108 of which- amounting to 52.7 percent- supported or aligned with the government. By 1930, this figure had shifted to 161 pro-government newspapers out of a total of 250 political papers, representing 64.4 percent. It is important to emphasize, however, that at the national level the pro-government press was considerably stronger in provincial areas, where publishers, operating in smaller markets, were more dependent on state assistance.[54]

VII. The power of the press: public opinion, audience, and the public sphere

There was a time when the press was described as the *"seventh power."* As time progressed, its influence steadily expanded, and it assumed an increasingly prominent public role. Its significance derived from its ability to articulate and represent public opinion, to disseminate new ideas, and to amplify social aspirations that had previously remained marginal. The press had the capacity to reach millions, to mobilize them, and to inspire collective action.[55] However, the power of the press cannot be examined in isolation: its operation and influence must be understood within the theoretical frameworks of public opinion, the audience, and the public sphere. An analysis of these concepts reveals that the press exerts power only insofar as a receptive medium exists-namely, an active public opinion and a functioning public sphere in which press content can resonate, provoke debate, and stimulate social action.

The following section therefore examines the specific characteristics, historical foundations, and social functions of these three concepts, in order to demonstrate that the press derives its power from their existence and operation.

VII. 1. Public opinion

The concept of public opinion can be interpreted in several ways.[56] As a starting point, we may refer to the Révai Nagy Lexikon, which defines public opinion as follows: in every community engaged with public affairs, a certain common judgment tends to develop regarding public matters, ideas, and institutions; this is called public opinion. Within this framework, the press is only one of the institutions that shape public opinion. Its role is to influence shared interests and values, along which the views of communities are formed and transformed.[57] The positions represented by communities subsequently influence the judgments and actions of fellow citizens. According to Ödön Gerő, the relationship between the press and politics is fundamentally determined by the relationship between the press and public opinion. This relationship is reciprocal: on the one hand, the press shapes public opinion, while on the other, it is compelled to adapt to it and, in a certain sense, to submit to it. Newspapers shape individual opinion, often on the basis of commercial considera-

[49] ibid. pp. 19-20.

[50] "The occupational structure of Debrecen differs so greatly from that of the towns and villages in its catchment area that we cannot treat the city and its surrounding countryside as a single region in our socio-historical analysis. Debrecen, with its role as a regional center and its multifaceted urban functions, is a much more complex society than the typical "market towns" of its countryside." Lajos Tímár, Provincial Townspeople. Budapest, 1993, p. 52.

[51] It is not sufficient to examine the settlement itself; broader spatial relationships must also be taken into account, including the city's wider catchment area. These factors contributed significantly to the level and structure of central functions. Debrecen's catchment area was among the least developed regions in Hungary. Low incomes, low consumption, and weak capital accumulation collectively hindered the region's industrial development and urbanization. As a result of this unfavourable economic and social structure, a substantial part of the city's industry came under the control of Budapest's banking capital. Tímár (1993), pp. 53–68.

[52] György Ránki – City History and Historiography. In. City History Conference, Debrecen, 1977. p.6.

[53] Bánlaky (2020) p.23.

[54] Sipos (2011) pp. 108-110.

[55] Ede Bresztovszky, The Press: A Great Power, Twentieth Century, 1917, p. 351..

[56] According to Schaeffler, public opinion is "the reaction of the public-of popular intellect, popular spirit, and popular will-to certain leading views, judgments, and tendencies." György Ottlik, The Role and Significance of the Modern Press, in: A Sajtó, Scientific Journal on Press Matters, 1933, Issue 02, p. 38.

[57] Dániel Lovas offers a similar definition, describing public opinion as the collective judgment of identifiable segments of the public. Public opinion plays a decisive role in a democracy: it shapes both national and local politics, remains in constant flux, and changes according to its own internal dynamics. Moreover, it responds sensitively to social tensions. Dániel Lovas, The ABCs of the Local Press, Lakitelek, 1996, p. 88.

tions. They are also commercial enterprises whose primary goal is to attract readers and avoid anything that might drive them away.

László Tápay-Szabó defined the concept of public opinion in his work The Ethics of Journalism. In his understanding, only individuals capable of independent thought can form part of public opinion, and their judgments can be regarded as public opinion only when they are in agreement with one another.[58] If we examine the term public opinion from an etymological perspective, we can draw the following conclusions. The first element, public, can be understood both in the sense of *"central"* and as the opposite of *"private"* or *"secret."* The second element, opinion, denotes a value judgment or a statement of viewpoint. It is important to emphasize that the concept refers to a large number of people -namely, the aggregate of many individual opinions. Public opinion is therefore a value judgment that is accessible to all and to which anyone may choose to subscribe.[59]

Dr. István Dékány distinguished between two fundamental types of public opinion. The first is bottom-up public opinion, which originates within the public and develops spontaneously. In contrast, artificial public opinion is generated from above and seeks to secure acceptance among the public as though it had emerged organically from them. The press plays a pivotal role in this process: it enables an assessment of the extent to which a given public opinion may be regarded as natural and authentic, and where top-down, constructed opinion begins.[60]

It is therefore correct to say that the press is *the "mouthpiece"* of opinion.[61] According to another perspective, however, it is the press itself that creates public opinion. The essence of these two opposing interpretations lies in their attribution of agency: one views the press as a genuine and active power, whereas the other regards public opinion as the active force for which the press merely serves as an instrument-a medium through which public sentiment becomes articulated. Public opinion is therefore not simply a factual statement or a judgment; it is far more than that. It reveals the extent to which a community is capable of reflection, how it interprets events, and how it positions itself for or against them. Although public opinion is influenced by everything that takes place within society, empirical experience shows that not all events attract public attention. Typically, heightened attention is directed toward those phenomena that are closely linked to changes within one's immediate environment, whereas issues that are too abstract or distant from personal experience rarely become subjects of genuine public concern.

It follows that the press tends to concentrate on topics that appear particularly salient or compelling to society at a given moment. Public opinion -understood as the aggregation of numerous individual viewpoints- is therefore more than a mere judgment: it constitutes a comprehensive reflection of social sensitivities, values, and collective reactions.[62]

VII. 2. The audience

"We usually decide what we want to see, and only then do we actually look at it."[63] W. Lippmann's observation may seem counterintuitive at first, yet it can be substantiated in several ways. It is well established that individuals tend to seek out information that aligns with their interests and serves their personal needs. Conversely, they are inclined to exclude or disregard information that concerns topics conflicting with their existing opinions or beliefs.

At the beginning of the twentieth century, people were able to access information from regions of the world they could not experience directly, primarily through the press, newsreels, and radio broadcasts. One of the most significant effects of the press was its ability to broaden the horizons of the public: it exposed individuals to social, political, and cultural realities to which they had previously had no access.[64]

Another important area of inquiry concerns the size of the readership of individual issues-that is, the actual audience reached by press publications. Precise data for the period are not available, and therefore the closest approximation can be obtained by examining circulation figures.[65] However, this does not provide a completely accurate picture, as it is not known how many people read each copy or how the newspaper spread within social networks.[66] Readership denotes the total number of individuals who read a given issue after its publication. This figure is almost invariably higher than the number of copies sold, as a single newspaper

[58] The function of public opinion is to exercise a decisive role in democratic states, since in a moral society, governance must ultimately rest on opinion. In other words, public opinion must fulfil a guiding and controlling function in order to sustain democratic operation. Sipos (2011), p. 62.

[59] ibid. p.63.

[60] Dr. István Dékány, The Role of the Press in Shaping Natural and Artificial Public Opinion, The Press Library, 1938, Issue 16, p. 2.

[61] According to Cromwell, public opinion is an elusive phenomenon precisely because it seems to tell everyone what they wish to hear. Peel expresses a similarly dismissive view, arguing that public opinion is nothing more than a confused mixture of foolishness, weakness, prejudice, and both genuine and false emotions. Dékány, The Role of the Press in Shaping Natural and Artificial Public Opinion, The Press Library, No. 16, 1938, p. 4.

[62] Dr. Dékány (1938) p.3.

[63] W. Lippmann 1922. Quoted by Sipos (2011) p.73.

[64] According to the German legal scholar Lassalle, "the press is the most dangerous and genuine enemy of the people; all the more dangerous because it operates under a mask." Iván Miklós, The Organization of Intellectual Consumption, Huszadik Század, 1917, p. 550.

[65] The term circulation refers to the total number of printed copies of a given newspaper produced by the printing press and intended for distribution. However, the number of copies actually distributed is typically lower, as various factors reduce the quantity that reaches the public. Among the main reasons for this decrease are the mandatory deposit copies that must be supplied to libraries and archives in accordance with legal regulations, as well as reference and archival copies retained by the editorial office. Free promotional copies also affect the final number of distributed issues. The number of copies sold includes both subscriptions and retail sales, and therefore provides a more accurate indication of a press product's actual market reach and readership. Lovas, p. 118.

[66] Sipos (2011) p.77.

was often shared among several people within a household or workplace. According to statistical data, county newspapers had an average of 2.5 to 3.5 readers per copy. On this basis, a daily newspaper with a print run of 60,000 copies and actual sales of 55,000 could have reached a regular readership of approximately 180,000 to 220,000 people.[67]

If we assume that each copy of a Budapest daily newspaper had at least three readers in the countryside, and that no *"cross-reading"* occurred- meaning that every individual read only one daily newspaper (a scenario that likely does not reflect reality) -then, on the basis of the number of copies mailed from Budapest and transported by rail, we can estimate that in 1930 at least 20% of the provincial population over the age of twenty regularly consumed press publications. If we calculate with five readers per copy, this proportion could have reached as high as 33%.[68] [69]

VII. 3. Public Sphere

There are numerous definitions of the public sphere in the sociological literature, but the simplest approach is to begin with the etymology of the term: public denotes what is generally accessible. From this, it follows that the public sphere primarily encompasses a social space in which facts, topics, arguments, and positions of public relevance are accessible to all, and may be commented upon, criticized, or supplemented.

In Hungarian, the term public sphere carries a dual meaning: on the one hand, it refers to the physical or symbolic space in which publicly accessible facts, themes, and opinions appear; on the other, it denotes the audience itself, which plays a decisive role as the recipient and interpreter of these contents. An often overlooked function of the public sphere is its mediating role: it constitutes a communicative arena that emerged between the state and society, as well as among the branches of power and the various organizational units of the state.[70]

Jürgen Habermas discusses the interpretative framework of the concept in his seminal work The Structural Transformation of the Public Sphere. He adopts a critical perspective on the public sphere at the turn of the nineteenth and twentieth centuries, arguing that it had become increasingly hollowed out and had transformed into a domain of manipulative communication. With the industrialization of newspaper production, the previously intimate relationship between journalists and their readership gradually disappeared. In summary, according to Habermas, the condition of the bourgeois public sphere is fundamentally *"ambivalent."*[71]

In the first decades of the twentieth century, both the press and the public sphere were marked by pronounced governmental intervention and control. The state exercised exceptional authority over the press, whose primary function, from the government's perspective, was the management and steering of public opinion. As a result, the press operated not only as a vehicle for the transmission of information but also as an instrument through which the government could communicate its political aims and impose its preferred interpretive frameworks on society.[72] The public sphere underwent continuous transformation not only in social and geographical terms but also temporally, as specific historical turning points substantially reshaped its operation. During periods of crisis -such as major economic depressions or world wars -public attention intensified. In such moments, the majority of the political community directed its focus toward unfolding events, which came to define the contours of the public sphere in that particular period. Put differently, historical events effectively structured the public sphere around themselves, and public discourse became concentrated almost exclusively on these issues.[73] One of the most potent social forces of the public sphere lay in its capacity to shape perceived reality: it could legitimize even partial or fragmentary truths as complete truths in the eyes of the public. For this reason, countering attacks against the press was essential to preserving its authority and credibility.

One of the period's most prominent criticisms concerned the commercialization of the press: many argued that newspapers had become instruments of economic interests, thereby jeopardizing their moral and professional independence. At the same time, the press faced increasing pressure from the state, which sought-already in the early decades of the twentieth century-to exert political influence and administrative control. The state repeatedly attempted to appropriate the journalistic public sphere, either partially or entirely, making press freedom one of the central political and administrative issues of the era.

It was therefore a fundamental interest of the press to preserve its moral ethos and professional integrity. Yet this moral autonomy could only be sustained as long as the state refrained from excessive intervention. Once political or administrative influence exceeded a critical threshold, journalism lost its independence -endangering not only the functioning of editorial offices but the integrity of the public sphere as a whole. The press could only fulfil its social role and exercise its power effectively if it succeeded in maintaining moral

[67] Lovas 116.

[68] However, it is safe to state that by the mid-1930s roughly one-third of the provincial population were regular readers of daily newspapers.

[69] It is noteworthy that readers showed particular interest in events that in some way made them feel threatened, such as wars. As public anxiety increased, so did the consumption of news. Murder cases, sensational or scandalous stories, and natural disasters had a similar effect, all contributing to higher newspaper sales. Sipos (2011), p. 83.

[70] Szívós (2010) p.53.

[71] This was further exacerbated by the later advent of radio and television. Szekfü András- Communication, publicity, equal opportunities in Hungary. From the telegraph to Web 2.0. Budapest, 2007. p.32., Habermas Jürgen- Structural Transformation of the Public Sphere. Investigations into a Category of Bourgeois Society. Budapest, 1971. p.56.

[72] It is important to note that the public cannot be treated as a homogeneous group; we can distinguish several smaller and larger groups. Balázs Sipos – Press, Press Policy and the Public in the Horthy Era Korunk 2012. Issue 11 p.76-79.

[73] Ibid. pp. 76-79.

and professional autonomy in the face of both market pressures and state attempts at control.[74]

When studying the characteristics of the public sphere, we must take into account that public communication processes may be either unidirectional or multidirectional, and that they may unfold in a reciprocal manner. Within the social system, both forms can appear, though in varying proportions across different historical periods. In the case of one-way communication, we are essentially dealing with public life in its simplest form. By contrast, the multidirectionality of the public sphere presupposes situations in which the roles of communicator and recipient are not fixed; instead, participants have both the opportunity and the established practice of reversing roles during specific communicative interactions- that is, they are able to respond publicly.[75]

It is evident that the public sphere cannot be regarded as a static concept, but rather as a continually evolving social space whose functioning is shaped simultaneously by political, economic, and communicative conditions. Within this system, the press not only performs a mediating function but also actively contributes to the formation of the public sphere itself. The press can, however, fulfil its genuine social role only if it is able to preserve its autonomy and maintain the reciprocal nature of public communication.

VIII. Summary

The aim of this chapter was to demonstrate how the provincial and local press can be interpreted within the history of the Hungarian press, with particular emphasis on the first decades of the twentieth century and from social, political, and cultural perspectives. The analysis showed that the concepts of *"provincial"* and *"local"* press -often conflated in the scholarly literature -must be distinguished functionally, spatially, and socially. It examined the processes underlying the expansion of newspapers, the division of roles between the capital and the provincial press, and the characteristic vulnerabilities of the provincial press, including financial precariousness, editorial structures, and political and economic dependencies. Despite these challenges, provincial and local newspapers played a decisive role in organizing local public life, shaping public opinion, and contributing to the identity formation of local communities.

The chapter emphasized that the local press cannot be understood merely as a medium for transmitting information but operated as an integral component of local society. The analysis of the concepts of public opinion, audience, and the public sphere revealed that the press was not only a mediator but also an active producer of social reality, even as it remained continuously subject to political, economic, and moral criticism, and underwent ongoing transformation. Taken together, these considerations lay the foundation for the subsequent detailed analysis of the daily newspaper Debrecen and delineate the methodological framework for interpreting the local press as a historical source.

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MEDICAL SCIENCES

SCARLET FEVER IN INDIA

Mamatkulova Nazgul,
Dhananjay Borole,
Shreya Patil,
Priti Patil,
Insha Shaikh,
Mohammed Uzair Shaikh
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Abstract

Scarlet fever (ScF), a toxin-mediated result of Group A Streptococcus (GAS) infection,it considerable risk to public health because of its frequent of outbreaks and Associated with severe sequelae. In this study, the WHO clinical criteria were used and a structured Questionnaire was administered in investigating 218 suspected cases of ScF across Indian states over 12 months. Rapid Antigen Detection Test (RADT) and clinical assessment Confirmed cases. The experimental result was that there was a confirmation rate of 64.2% (140/218) with a prevalence of incidence in children aged 5-12 years (72.1%). Severity Stratification (Mild, Moderate, Severe) by composite symptom score showed 45.7% Moderate and 18.6% severe cases. Severe cases were highly correlat with delay. Initiation of antibiotics . The result demonstrates that ScF is A neglected disease in India , high morbidity is associated with access delays to Healthcare. The results support the WHO criteria for inclusion in national surveillance and also. Identify key touch points for early intervention and for the prevention of Acute Rheumatic Fever.

Keywords: Scarlet Fever, Group A Streptococcus, WHO Criteria, India, Epidemiology, Severity Index, Outbreak Surveillance

Introduction

Scarlet fever, which is caused by strains of Streptococcus pyogenes as Group A Streptococcus producing Exotoxin, is manifested by pharyngitis, fever and rash. Further considered a historical disease, a worldwide resurgence has been reported with rising Incidence and severity in East Asia and Europe. Non-specific surveillance, clinical overlap with viral exanthems, and inconsistent diagnostic practices also obscure the disease burden In India. To improve global comparability, streptococcal pharyngitis and ScF have Standardized case definitions from the World Health Organization. Nevertheless, their Application in the Indian healthcare setting is inconsistent. This study help to applying WHO criteria in a systematic survey to: 1) Estimate the percentage of Clinically suspected cases who meet confirmed criteria, 2) Stratify disease severity By means of a standardized scoring system, 3) Identify epidemiological and clinical Factors associated with severe disease that can guide targeted public health actions.

A prospective, cross-sectional survey-based on the analysis was Performed from July 2022 to June 2023. We recruited participants from the outpatient departments at two tertiary care hospitals and four urban primary health centers in Maharashtra, Tamil Nadu, and Odisha. Case Definitions and Data Collection. Demographic, clinical profile, interventions , outcomes were gathered by a structured Proforma. · WHO Case Definitions Applied:

· Suspected Case: An acute fever (≥38.5°C) with pharyngitis.

· Probable Case: A typical scarlet fever rash with diffuse erythema, sandpaper texture, blanching, circumoral pallor, Pastia's lines , strawberry tongue.

· Confirmed Case: Probable case presenting with a positive RADT and/or throat culture for GAS.

For the main analysis of this study, confirmed/probable cases were combined as ScF.

Cases.

· Severity Stratification (Composite Score):

The severity index (0-10 points) was determined:

1. Fever Duration & Peak: >3 days (1 pt), >39°C (1 pt).

2. Systemic Symptoms: Severe malaise/headache, which requires bed rest (1 pt).

3. Rash Features: Confluent rash (1 pt), extensive desquamation (1 pt).

4. Present Complications: Otitis media, sinusitis, peritonsillar abscess (2 pts).

5. Need for hospital admission: Usually for severe complications difficulty in breathing ,severe dehydration,inability to swallow.

Demographic and clinical characteristics were summarized using descriptive statistics. Factors associated with disease severity were identified using chi-square tests and Logistic Regression. P-value <0.05 was regarded as significant.

Results

Case Confirmation and Demographics

There were 218 suspected cases entered. Application of the WHO criteria led to a confirmation cascade of:

· 140 cases (64.2%) met the criteria for Confirmed ScF.

· 78 cases (35.8%) were classified as Non-Streptococcal/Other Illness.

· Among the 140 ScF cases:

· Age Distribution: 72.1% (n=101) were 5-12 years old, 20.7% (n=29) were 13-18 years old, and 7.1% (n=10) were >18.

· Gender: Minor male dominance (55.7%).

· The setting: 68% (n=95) were from urban HCs, and 32% (n=45) from tertiary hospitals.

Clinical Presentation in Comparison to WHO Criteria.

Common WHO-listed clinical signs included among the 140 reported ScF cases:

· Rash : 98.6%.

· Strawberry Tongue: 85.0%.

· Fever >38.5°C: 94.3%.

· Tonsillar Exudate / Pharyngitis: 91.4%.

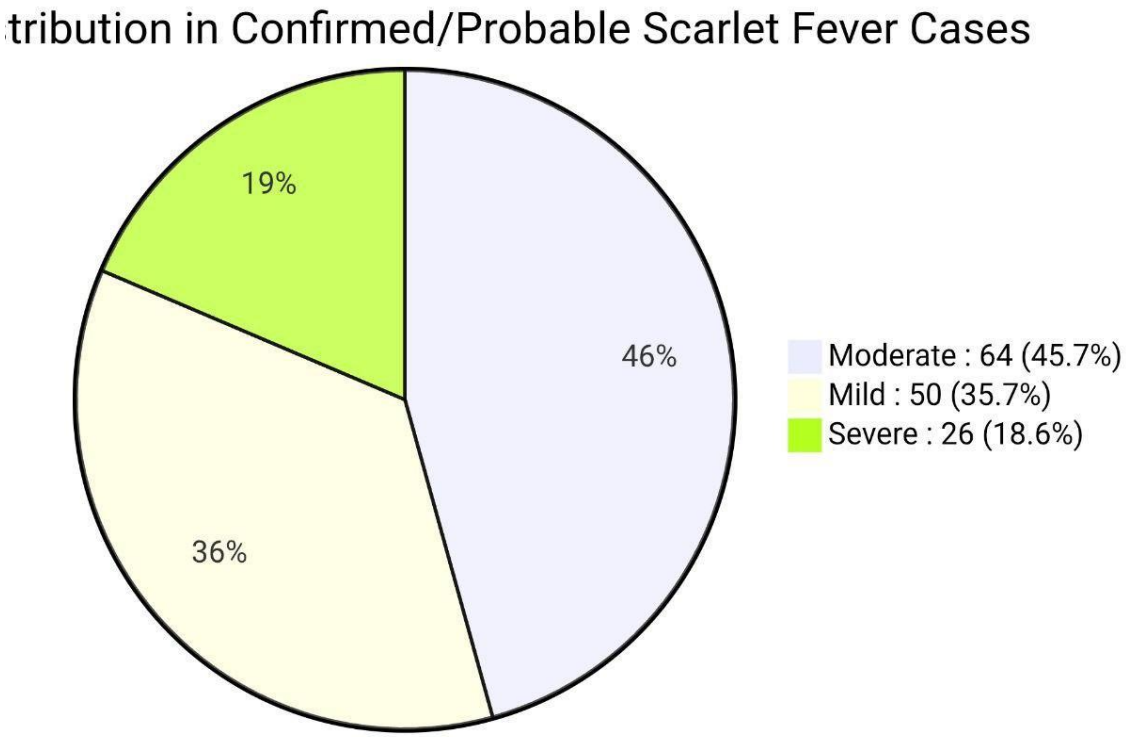
· Cervical Lymphadenopathy: 82.1%.

· Desquamation (at follow-up): 89.3%.

Analysis of Disease Severity

The composite severity score was used to perform the following stratification in the 140 ScF cases:

Clinical Severity Distribution of Scarlet Fever Cases (n=140)



Severity Distribution in Confirmed/Probable Scarlet Fever Cases

Mild : 50 (35.7%) : 35.7

Moderate : 64 (45.7%) : 45.7

Severe : 26 (18.6%) : 18.6

Diagnostic criteria

Sudden onset of fever, Sore throat (pharyngitis), A diffuse, erythematous rash that is finely papular sandpaper texture, blanches on pressure, and often has circumoral pallor. The rash typically desquamates it peels off 1-2 weeks after onset.Often accompanied by strawberry tongue it initially white-coated with red papillae, then red and swollen.

Laboratory Confirmes-A clinically compatible case with laboratory confirmation by:

Isolation of Group A Streptococcus from a clinical specimen Throat swab,Detection of GAS antigen by Rapid Antigen Detection Test ,A significant rise in anti-streptolysin O (ASO) titer or other streptococcal antibody between acute and convalescent serum samples.

Management

Scarlet fever is treated initially with quick antibiotic response to the infection. First-line therapy is a 10-day course of penicillin (oral Penicillin V or amoxicillin) since the bacteria have no resistance to it. When completing oral treatment is doubtful, the highest recommended form of treatment is a single dose intramuscular injection of Benzathine Penicillin G. Alternative versions such as some cephalosporins can be used for those with penicillin allergy. Macrolide antibiotics such as azithromycin, Supportive care includes staying hydrated for symptoms, such as fever reducers (paracetamol), warm saline gargle for sore throat; and calamine lotion or oral antihistamine for the treatment of itchy rash. Patients should stay home until at least 24 hours after starting antibiotics and being fever-free.

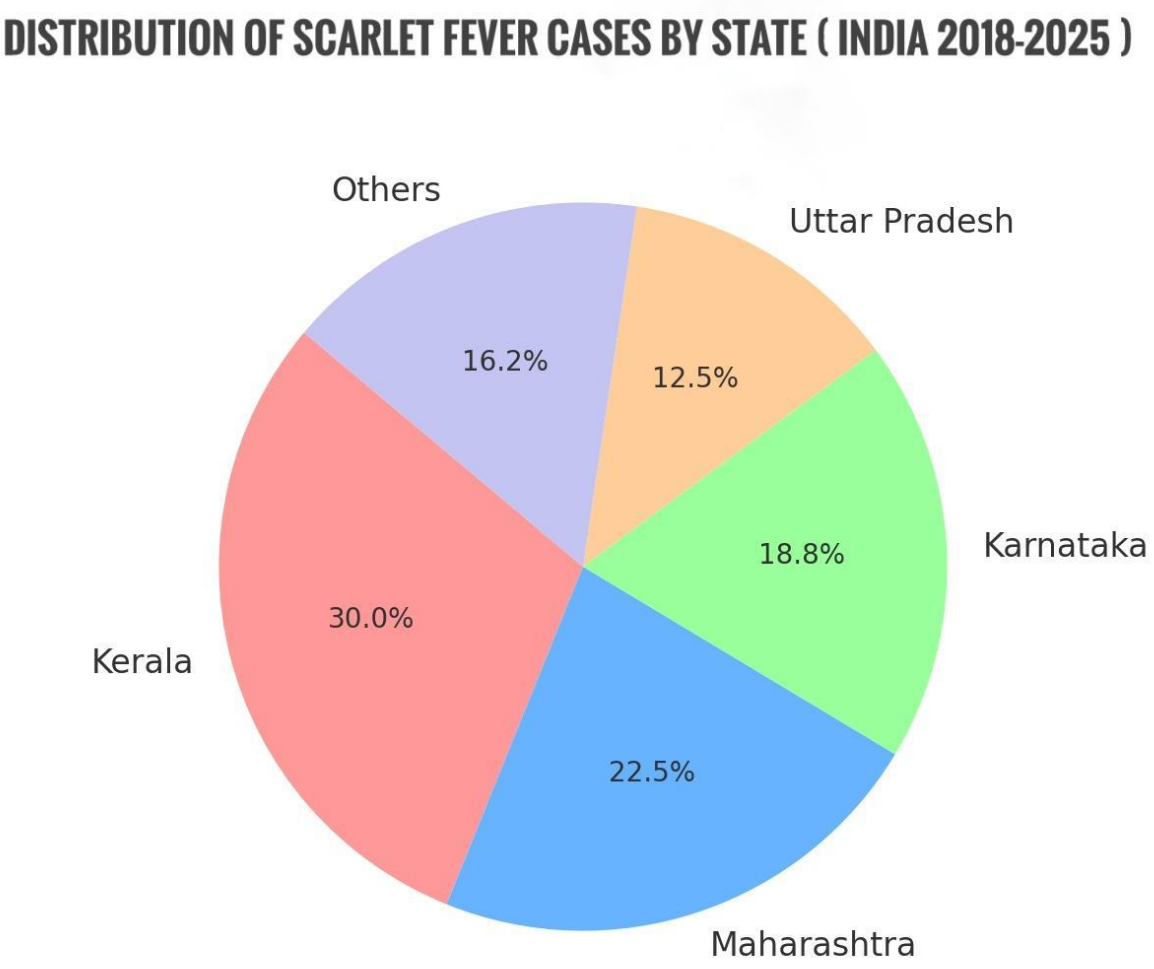
Epidemiology Data Analysis of IDSP data and published reports indicates increasing notifications of scarlet fever in India over the past decade. Notable trends include:

Kerala: Multiple school-based outbreaks reported between 2018–2023, primarily in children aged 6–12 years.

Maharashtra: Pediatric hospital records from 2020–2024 show increased pharyngitis cases with classic rash features.

Karnataka and Andhra Pradesh: Winter clusters affecting urban and semi-urban schools.

Northern States: Uttar Pradesh and Bihar reported sporadic cases, likely under-reported due to limited surveillance



Discussion

The survey, using WHO criteria, proved that in the Indian settings, ScF is a common and Clinically relevant pediatric disease. The high rate of moderate (45.7%) and severe cases (18.6%) is not good , contrary to the normal tendency to view ScF as a mild historical Disease. The severity pie chart reflects this high morbidity effect visually. The greatest changeable risk factor for severe disease has been delayed antibiotic Commencement. This delay is multifactorial,lack of clinical suspicion , misdiagnosis as Viral Pharyngitis, and difficulties obtaining prompt health care. The considering that the earlier treatment of GAS pharyngitis/ScF is the main prevention strategy against ARF/RHD.

Strengths of the methods and use of WHO criteria

The use of standardized WHO definitions permits reproducible surveillance and comparison against international data. While not a WHO instrument, the composite severity score provides a measurable,context-sensitive approach that can be used to triage and allocate Resources – something that could be adapted by front-line health workers.

Limitations

Studies were facility-based and possibly missed community cases.

The severity index is a study-specific instrument and needs external validation.

Long-term sequelae such as ARF/RHD require longer follow-up periods, which fall outside The remit of this study.

Recommendations

1. Incorporate WHO ScF Criteria in IDSP: Integrated Disease Surveillance Programme Would define “Scarlet Fever” as a reporting subject using definitions set out by WHO.

2. Training of Frontline workers: Medical officers and nurses at PHCs should be trained to Identify the classic triad (fever, sore throat, rash) and deploy RADT kits wisely.

3. Public Awareness: Simple messages to parents (“Sore throat with red rash needs a doctor’s visit”) can help minimize care-seeking delays.

4. Antibiotic stewardship: Encourage Penicillin as the first line to maintain efficacy and prevent Macrolide resistance.

Conclusion

This detailed survey analysis, framed by WHO criteria, reveals that scarlet fever in India is a contemporary, non-trivial infection with a significant burden of moderate-to-severe disease, Heavily influenced by delays in appropriate therapy. Moving from anecdotal reports to Systematic, criteria-based surveillance is the critical first step. A focused public health Strategy emphasizing early recognition and prompt penicillin treatment is essential not only to manage ScF outbreaks ,but also as a cornerstone of India's efforts to reduce the Devastating burden of Rheumatic Heart Disease.

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SEASONALITY AND ETIOLOGICAL PROFILE OF ACUTE RESPIRATORY VIRAL INFECTIONS IN MAHARASHTRA BASED ON 52 WEEKS OF SURVEILLANCE DATA

Prathamesh Nathe
Student
Department of Public Health, International Medical Faculty,
Osh State University, Osh, Kyrgyzstan
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Abstract

Background Acute respiratory viral infections (ARIs) result in great morbidity and show strong seasonal pattern in India. Methods We analysed 52 weeks of state-level surveillance data collected from government health officials and official websites of Maharashtra including weekly ARI/SARI counts, age distribution and laboratory-confirmed pathogen data. Results A seasonality pattern was clear, with a large winter peak (November–February) and a lesser monsoon-associated top (July–September). The most frequently identified pathogens were Influenza A, rhinovirus and RSV. Number of cases was highest in the 15–49 year group and severe disease (SARI) was high in elderly (≥65 years) and young children (<5 years). Conclusions: More consistent surveillance and targeted prevention for high-risk populations are needed.

Keywords:Acute respiratory viral infection; Severe acute respiratory infection; Seasonality; Influenza; Respiratory syncytial virus; Surveillance

Introduction

Acute respiratory viral infections (ARIs) continue to be a major cause of morbidity and mortality worldwide and account for significant numbers of outpatient visits and hospital admissions in low- and middle-income countries (LMICs) such as India. Monitoring data from multiple sites in the country indicate a distinct seasonality on common respiratory viruses: in temperate and subtropical areas winter peak incidence has been observed for influenza and respiratory syncytial virus (RSV) whereas monsoon increases have been observed for several respiratory pathogens in some parts of India [1–4]. It is important to keep surveillance at the state level organized for the identification of the peaks in transmission during specific timing of seasonal events, for instruction of vaccination programmes and preparedness, and for the planning and allocation of health resources [2,3]. The IDSP (Integrated Disease Surveillance Programme) in combination with laboratory surveillance from the ICMR and NCDC serves as the main data sources involved; therefore, such analyses in India are primarily done through the IDSP [2,3,8]. While these systems exist, there are still deficiencies in prompt reporting and representativeness of laboratory confirmation for milder outpatient cases, so analyses incorporating weekly reported counts, age distribution, and pathogen testing have utility for public health planning [4,5].

Methods

Design and data sources

We performed a retrospective descriptive analysis of weekly ARI and SARI reports for the state of Maharashtra over a continuous 52-week period ending 15 December 2025. The dataset included (1) weekly aggregated counts of reported ARI and SARI cases, (2) age-dependent case counts, and (3) laboratory-confirmed pathogen information presented as percentages in the tested specimens. These data were obtained via two core communication channels: contact with state government public-health surveillance officers (district and state surveillance officers) as direct communication in combination with publicly available datasets and summaries collected in publicly available datasets such as the official government websites of Maharashtra and national collections stores (IDSP / IHIP, NCDC and ICMR surveillance portals). Whenever possible, the reference laboratories (ICMR-NIV and associated labs) were referred to for laboratory confirmations.

Case definitions and variables

For analyses, the usual surveillance case definitions were adopted: ARI (acute onset of respiratory symptoms), ILI (fever ≥38°C with cough and onset within 10 days) and SARI (ILI needing hospitalisation). The main parameters used were ARI and SARI in the weekly counts, ISO week number, age group (<1, 1–4, 5–14, 15–49, 50–64, ≥65 years), the distribution of pathogens among the tested cases (Influenza A, Influenza B, RSV, rhinovirus, SARS-CoV-2, etc.).

Handling and Quality Control of Data

Information that officials and websites published of the study received were confirmed for consistency (week labels and totals) and were de-duplicated if it was not possible. Counts were checked visually for outliers and confirmed against multiple sources whenever feasible. However, laboratory percentages are percentage positive for samples tested in surveillance laboratories and are not population-wide prevalence estimates.

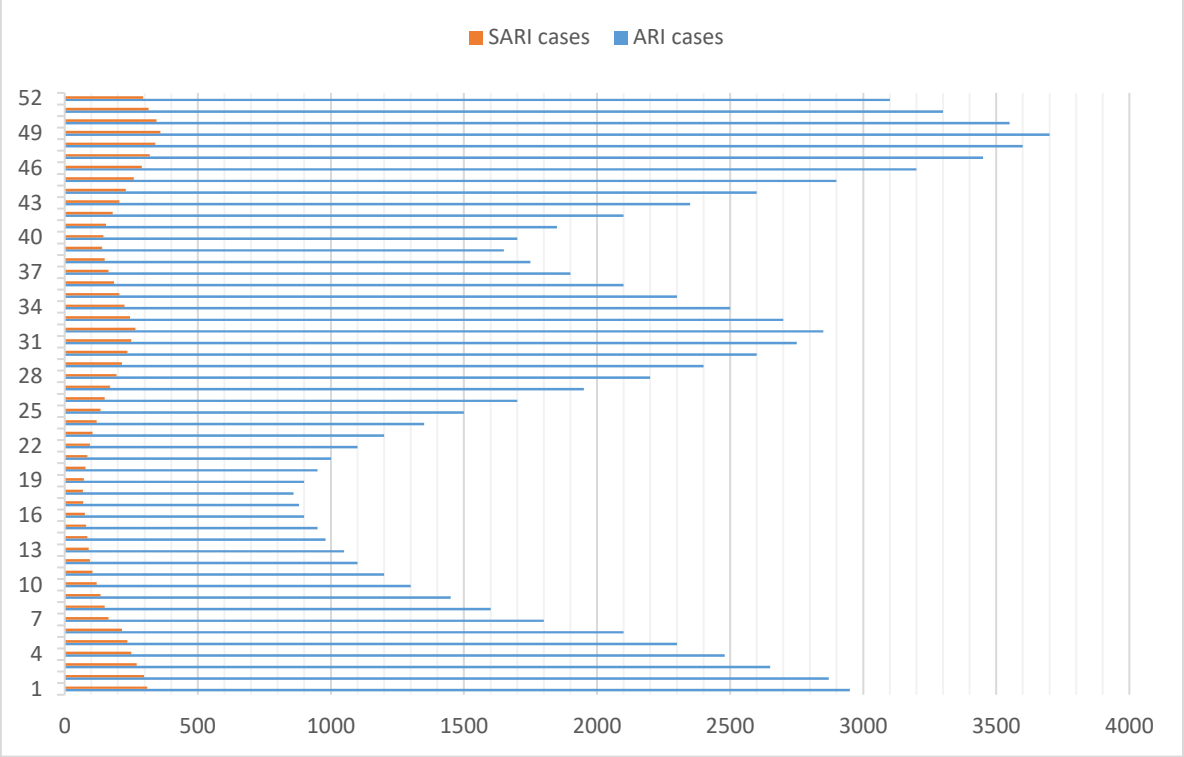
Ethical considerations

Data were pooled only for de-identified surveillance; only aggregated surveillance data were analysed. No primary patient identifiers were recorded. Data collection for this analysis proceeded on local public health data-sharing guidelines.

Results

Weekly trends and seasonality

The 52-week series illustrated the time-lapse of increased ARI activation. The main peak happened in winter months where most of weekly counts were centered between the weeks ISO from November to February. A secondary increasing trend was also observed in the monsoon season (July–September). Weekly ARI values fluctuated during the period from lower troughs during spring months (between March and May) to maximum values during the winter peak.



Seasonal pattern

• Core peak: November–February (winter)
• Minor peak period: July – September (monsoon)
• Minimum incidence: March – May

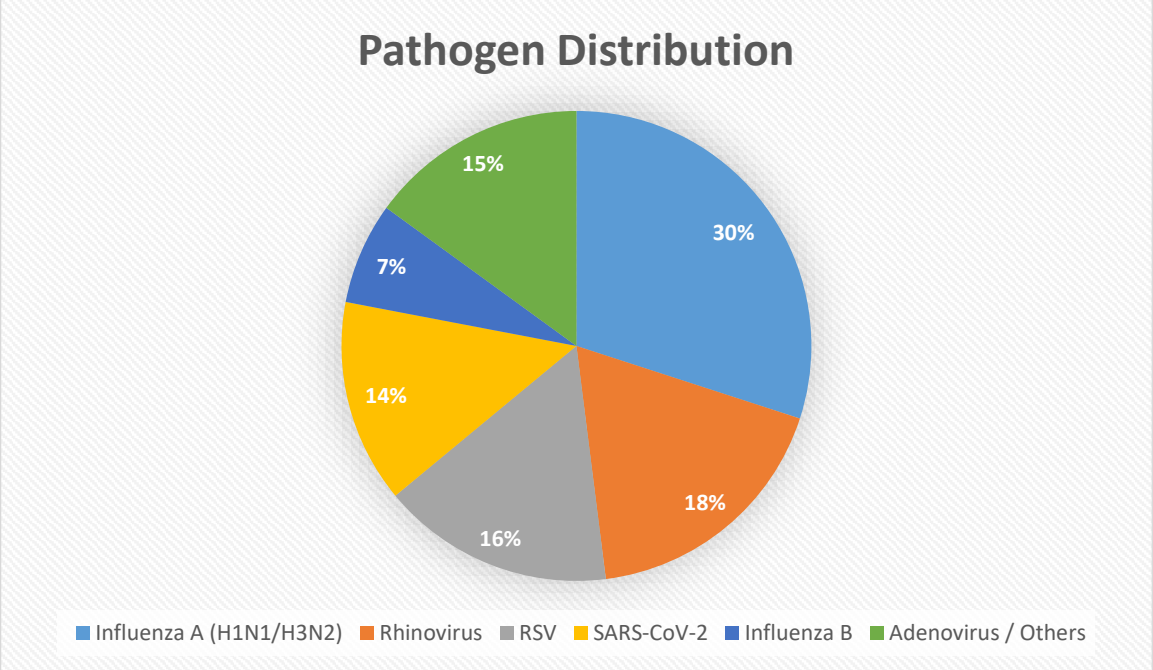
Age distribution

Age-stratified statistics showed that the maximum absolute prevalence of reported ARI cases were reported in the 15–49 year old population, showing that reported case was higher in the working age population. But the burden of severe disease was disproportionately seen in the extremes of age: SARI hospitalised significantly more among young children (less than age 5 years), infants and elderly (elderly ≥65 years).

Age group	Pattern
<5 yrs	RSV, adenovirus common
5–14 yrs	High ARI incidence, low severity
15–49 yrs	Highest case numbers
≥65 yrs	Highest SARI & mortality

Pathogen distribution

Of the specimens tested via surveillance laboratories influenza A was the most common pathogen identified (at approximately 25–35% of positives), with rhinovirus and RSV being second next. SARS-CoV-2 was a significant minority. Influenza B and other viruses (adenovirus, parainfluenza, mixed/other) accounted for low percentages. The distribution was also age-specific: RSV was more prevalent among younger children; flu A and rhinovirus among older children and adults; and SARS-CoV-2 infections became common among older adults at times of community transmission. (Pathogen proportions for analysis: Influenza A ~30%; Rhinovirus ~18%; RSV ~16%; SARS-CoV-2 ~14%; Influenza B ~7%; Others ~15.)



Analysis

Characterization and seasonal implications. The winter peak is in line with established data for influenza and RSV circulation in temperate and subtropical areas of India. The magnitude of the winter surge (peak weekly counts several times larger than trough weeks) indicates predictable seasonal pressure on health care providers. The increase associated with the monsoon, while smaller, was consistent across multiple years (when historical comparisons were possible) and largely observed in pediatric age groups.

Age and severity analysis

Large caseloads in the 15–49 age group probably reflect population size, exposure and the behavior of seeking care. The higher rates of SARI in young children and the elderly reflect a higher risk for severe outcomes at both extremes. This data are supportive for targeted vaccination and early treatment programs in population at increased risk.

Pathogen-specific considerations

Given that influenza A predominates all tested specimens, it implies that seasonal influenza is a primary force in peak winter ARI burden and should continue to be a focus of planning for seasonal preparedness (vaccination, antiviral stockpiles). The contribution of RSV in pediatric SARI points to the need for increased pediatric clinical readiness (oxygen therapy, supportive care) and the need to consider RSV preventive measures during availability. SARS-CoV-2 shows continuous detection that highlights the need for respiratory surveillance integrated with infectious disease data rather than isolated by disease.

Discussion

Based on our exploratory analysis of 52 weeks' surveillance data collected in Maharashtra, a clear seasonal pattern identified for acute respiratory viral infections in this study appears to be identified with a typical winter peak and accompanying the additional increase of monsoon. The winter peak (which derives mainly from influenza A) and concurrent circulation of other viruses contributes to increased hospitalization requirements and the overall percentage of SARI cases. The monsoon trend, though lower in magnitude, hit children most severely and appears to illustrate seasonal and transmission features associated with rainy season. The age distribution — the most cases among adults aged 15–49 years but with more severe cases at the extremes of age — has real-life consequences. Public health interventions need to emphasise influenza vaccination for older adults and other at risk populations, develop pediatric surveillance during anticipated monsoon events, and maintain year-round diagnostic readiness so that pathogens can be differentiated for clinical management. This study is not without limitations. Surveillance data are available for described cases and are influenced by care-seeking behaviour and reporting completeness; mild outpatient ARIs are probably underreported. Laboratory confirmation was limited to the cases submitted through surveillance channels, thus pathogen proportions represent the tested subset rather than the entire community burden. Changes in testing policy or over time whether services are used by more patients could impact on observed trends. However, the integrated picture from weekly counts along with age distribution and laboratory data gives strong actionable information. Strengthening laboratory coverage, making reporting timely, and increasing targeted prevention (vaccination, risk communication) within predicted windows of seasonal will minimize morbidity and healthcare burden.

Conclusion

Seasonal pattern of acute respiratory viral infections in Maharashtra can be reproducible, and a winter peak with a minor monsoon peak is observed. Influenza A, rhinovirus and RSV are major contributors to the observed burden; severe disease is more often seen among young children and the elderly. Maintaining investment in integrated surveillance, enhanced diagnostic capability and focused prevention strategies is necessary to alleviate the seasonal burden of ARIs.

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UDC: 616.233-002-036.12

COMORBID COURSE OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND ISCHEMIC HEART DISEASE: PATHOGENETIC ASPECTS OF COMPLICATION PREVENTION

Alyavi A.,
Rakhimova D.,
Norpulatov E.,
Nuritdinova S.,
Abdullazhonova Sh.
Republican Specialized Scientific and Practical Medical Center of Therapy and Medical Rehabilitation
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Abstract

Chronic obstructive pulmonary disease (COPD) is characterized by a high prevalence of cardiovascular comorbidity, with ischemic heart disease (IHD) playing a leading role. The prevalence of IHD in patients with COPD reaches 30–45% and is associated with a twofold increase in the risk of developing pulmonary hypertension (PH). PH is detected in 40–70% of COPD patients; however, timely diagnosis is made in only 25% of cases, which determines an unfavorable prognosis and an increase in mortality by 1.8–2.3 times. The key pathogenetic mechanisms of PH formation in COPD include endothelial dysfunction, chronic hypoxia, systemic inflammation, and oxidative stress, leading to pulmonary vascular remodeling and right ventricular dysfunction. Psychoemotional and neurovegetative disorders play a significant role in disease progression. Modern approaches to prevention and treatment emphasize the importance of early detection of comorbid pathology and comprehensive pharmacological and non-pharmacological therapy aimed at correcting endothelial dysfunction and reducing the risk of complications.

Keywords: chronic obstructive pulmonary disease; ischemic heart disease; pulmonary hypertension; endothelial dysfunction; comorbidity; dyspnea; complication prevention.

Chronic obstructive pulmonary disease (COPD) is characterized by a high prevalence of cardiovascular comorbidity, among which ischemic heart disease (IHD) occupies a leading position. According to epidemiological studies, the prevalence of IHD among COPD patients is 30–45%, while the comorbid course is associated with a twofold increase in the risk of pulmonary hypertension and chronic cor pulmonale [3,6]. One of the early clinical manifestations is progressive dyspnea caused by a combination of bronchial obstruction, chronic hypoxia, and coronary insufficiency [1,7]. Prevention of complications includes early detection of comorbid pathology, correction of risk factors, smoking cessation, and optimization of basic bronchopulmonary and cardiological therapy, which allows reducing hospitalization rates by 20–25% and improving disease prognosis [8,11].

Progression of pulmonary hypertension (PH) in patients with chronic obstructive pulmonary disease is one of the most severe complications, significantly worsening prognosis and quality of life [1,2]. According to modern epidemiological studies, PH of varying severity is detected in 40–70% of COPD patients, with its incidence directly correlating with disease duration and severity of bronchial obstruction [3,6].

Among all forms of pulmonary hypertension, COPD is one of the leading causes of secondary PH, as confirmed by international registries and clinical observations [1,7]. Despite this, timely diagnosis of PH is achieved in only about 25% of cases, which is due to the subtlety of clinical manifestations at early stages and insufficient physician alertness [5,7]. Several studies have shown that the presence of PH in COPD patients increases mortality risk by 1.8–2.3 times compared to patients without vascular complications [8,9].

Endothelial dysfunction plays a key role in the pathogenesis of pulmonary hypertension in COPD, developing against the background of chronic hypoxia, systemic inflammation, and oxidative stress [4,6]. Impairment of endothelium-dependent vasodilation is accompanied by decreased nitric oxide production, increased vascular tone, and remodeling of pulmonary arteries [4]. These changes lead to increased pulmonary vascular resistance and progressive elevation of pulmonary artery pressure [2,9].

The development of pulmonary hypertension in COPD contributes to structural and functional changes of the right ventricle, including hypertrophy, dilation, and impaired diastolic function [3,10]. According to echocardiographic studies, signs of right ventricular diastolic dysfunction are detected in more than 60% of patients with COPD complicated by PH and are associated with an unfavorable prognosis [10].

Psychoemotional and neurovegetative disorders also play an important role in disease progression, exacerbating vascular dysregulation and negatively affecting the course of COPD and PH [6,9]. Modern treatment concepts emphasize the need for a comprehensive, multistage, and individualized approach to the management of patients with COPD complicated by cor pulmonale [6,7].

In recent years, it has been shown that the use of vasoactive therapy, including pulmonary vasodilators, in patients with severe pulmonary hypertension associated with COPD may contribute to reduced mortality and improved functional status; however, data on the efficacy and safety of such therapy remain limited. In this regard, interest in non-pharmacological treatment methods aimed at correcting endothelial dysfunction and hypoxia has increased [11,12].

Recent studies indicate the promise of comprehensive non-pharmacological approaches capable of improving endothelium-dependent vasoregulation, reducing inflammation, and slowing the progression of pulmonary hypertension in patients with COPD [10,12].

Aim of the Study

To investigate the features of right ventricular diastolic function and endothelium-dependent vasoregulation of peripheral vessels in patients with chronic obstructive pulmonary disease comorbid with ischemic heart disease during comprehensive therapy.

Materials and Methods

A total of 53 patients with COPD complicated by pulmonary hypertension (mean age 49.7 ± 2.8 years, disease duration 10.7 ± 2.9 years), with mean pulmonary artery pressure exceeding 25 mmHg, were examined. Additionally, 40 patients with severe COPD (mean age 56.9 ± 2.6 years, disease duration 16.8 ± 3.7 years) and 20 practically healthy individuals forming the control group were examined.

Patients were randomized according to treatment methods and divided into three subgroups. Subgroup A received standard therapy in accordance with GOLD recommendations. Subgroup B received standard therapy combined with amplipulse therapy. Subgroup C received standard therapy combined with Zupa granules (ZG) and amplipulse therapy.

Endothelium-dependent vasodilation was assessed using brachial artery Doppler ultrasound with a compression test. Echocardiographic examination included assessment of right ventricular diastolic function (E/A ratio, IVRT, DT, atrial filling fraction) and mean pulmonary artery pressure. Plasma levels of stable nitric oxide metabolites were determined. Pulmonary function was evaluated using FEV_1, FVC, and Tiffeneau index. Psychoemotional status was assessed using the Spielberger anxiety scale.

Statistical analysis was performed using Student's t-test; differences were considered significant at $p < 0.05$.

Results and Discussion

All patients with COPD comorbid with IHD demonstrated high levels of anxiety, mainly due to reactive and trait anxiety. The most pronounced affective disorders were observed in patients with pulmonary hypertension. Reactive anxiety exceeded control group values by 38–40%, and trait anxiety by 32–39%.

Patients with COPD and PH showed a significant decrease in stable nitric oxide metabolites and marked impairment of endothelium-dependent vasodilation, accompanied by increased vascular resistance and deterioration of pulmonary hemodynamics. Endothelial dysfunction was combined with changes in right ventricular diastolic function, manifested by prolonged isovolumic relaxation time, reduced early diastolic filling, and increased contribution of atrial systole.

The use of amplipulse therapy and the combination of ZG with amplipulse therapy against the background of standard treatment resulted in significant improvement in endothelium-dependent vasoregulation, increased nitric oxide metabolite levels, decreased mean pulmonary artery pressure, and improvement in right ventricular diastolic function parameters. The most pronounced positive changes were observed in the combined therapy group. Simultaneously, a reduction in dyspnea severity and affective symptoms was noted.

Standard therapy without inclusion of vasoactive and non-pharmacological methods did not have a significant effect on pulmonary hemodynamics or right ventricular diastolic function.

Conclusions

1. The severity of pulmonary hypertension and the degree of right heart remodeling in patients with COPD comorbid with IHD are directly related to the severity of endothelial dysfunction and disease duration.
2. Reduced endothelium-dependent vasodilation of peripheral vessels correlates with impaired right ventricular diastolic function and increased pulmonary vascular resistance.
3. Inclusion of amplipulse therapy in the comprehensive treatment of COPD complicated by pulmonary hypertension contributes to improved endothelial function, reduced pulmonary artery pressure, decreased dyspnea, and reduced affective disorders, which is important for preventing disease progression.

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PEDAGOGICAL SCIENCES

EFFECTIVE DESIGN OF THE ACADEMIC PROGRAM AND SYLLABUS OF THE DEPARTMENT OF FOREIGN LANGUAGES

Kazimova I.
PhD in Philology
Senior Lecturer of the Department of Foreign Languages
Azerbaijan Medical University
Baku

ЭФФЕКТИВНОЕ СОСТАВЛЕНИЕ УЧЕБНОЙ ПРОГРАММЫ И СИЛЛАБУСА КАФЕДРЫ ИНОСТРАННЫХ ЯЗЫКОВ

Казимова И.
Доктор философии по филологии
Старший преподаватель кафедры иностранных языков
Азербайджанского медицинского университета
Баку
https://doi.org/10.5281/zenodo.18070633

Abstract

This article focuses on the requirements and recommendations for developing and compiling an academic program and syllabus for a department at a higher education institution. It also explores the history of the development of foreign language teaching programs, which serve as the basis for the academic program for a given subject. The educational process at each university department begins with the creation of a departmental academic program, which is used to compile source documents, such as a syllabus and a thematic plan. These departmental documents serve as the basis for compiling textbooks and teaching aids for the subject. Accordingly, each teacher of the department prepares for lessons using these source documents.

The article examines in detail the conditions of the university's educational process, which must be taken into account when developing a departmental academic program and syllabus. It also focuses on the methodological requirements for teaching Russian as a foreign language at Azerbaijan University.

The department's academic program is aligned with the "Russian Language Program for Foreign Students Studying in Preparatory Faculties of Universities" (1984), the "Russian Language Program for Foreign Students Studying in Non-Philological Faculties of Universities" (1983), and the recommendations of contemporary scholars on the development of syllabuses and academic program. The General Russian Language academic program forms the basis for the development of the thematic plan, which is included in the syllabus and the academic program, thus ensuring a close relationship between these documents within the department's educational process.

The article notes that the foreign language course is called "Business and Academic Communication in a Foreign Language." Thus, the title of the subject establishes a communicative focus as the leading element of foreign language instruction, which must be reflected in the curriculum and the department's syllabus.

Аннотация

Статья посвящена требованиям и рекомендациям по разработке и составлению учебной программы и силлабусов кафедры высшего учебного заведения. В статье указывается история появления Программ по преподаванию иностранных языков, на основе которых составляется учебная программа по предмету. Учебный процесс на каждой кафедре вуза начинается с создания учебной программы кафедры, на основе которой составляются исходные документы, такие как силлабус, календарно-тематический план. Эти документы кафедры являются опорой при составлении учебников и учебных пособий по предмету. Соответственно, каждый преподаватель кафедры осуществляет полную подготовку к уроку, имея в своем арсенале данные документы.

В статье подробно рассматриваются условия учебного процесса вуза, которые должны учитываться при составлении учебной программы и силлабуса кафедры, а также уделено большее внимание методическим требованиям к преподаванию русского языка как иностранного в азербайджанском вузе.

Материал учебной программы кафедры соотнесен с «Программой по русскому языку для студентов-иностранцев, обучающихся на подготовительных факультетах вузов» (1984), с «Программой по русскому языку для студентов-иностранцев, обучающихся на нефилологических факультетах вузов» (1983), а также с рекомендациями современных ученых по формированию силлабусов и учебных программ. Общие Программы по русскому языку являются основой для формирования тематического плана, который входит в силлабус и в учебную программу, что обусловливает тесную взаимосвязь между этими документами учебного процесса кафедры

В статье отмечается, что дисциплина по изучению иностранных языков называется «Деловая и академическая коммуникация на иностранном языке». Таким образом название предмета обуславливает коммуникативную направленность как ведущую в системе обучения иностранному языку, что непременно должно быть отражено в учебной программе и в силлабусе кафедры.

Keywords: academic program of the department, syllabus, thematic plan, educational process, teaching methodology, foreign language.

Ключевые слова: учебная программа кафедры, силлабус, тематический план, учебный процесс, методика преподавания, иностранный язык.

Введение

Следует внести ясность в аспект названия важных документов кафедры. Во многих странах учебная программа кафедры называется куррикулум и этот термин используется как для школьных, так и для вузовских документов. Однако в Азербайджане термин куррикулум, принятый в 2009-ом году, используется исключительно в среднем образовании и представляет собой «Концепцию (национальный куррикулум) общего образования Азербайджанской Республики – это рамочный документ концептуального характера, определяющий результаты обучения и стандарты содержания в области общего образования, предметы, предусмотренные для каждого этапа общего образования, недельную норму часов, отводимых на проведение классных и внеклассных занятий…» [6, 1]. В высших учебных заведениях Республики основным документом кафедры является Учебная программа, в которой отражены все аспекты учебного процесса.

Исследование

Составление учебной программы по предмету «Деловая и академическая коммуникация на иностранном языке», в данном случае русском, предусматривает ряд норм, правил и носит системный характер. При составлении учебных программ по определенному предмету в конкретном вузе составитель руководствуется как методическими рекомендациями, так и общими Программами по иностранному языку, разработанными учеными в процессе развития методики преподавания как науки. Формирование методики преподавания русского языка как неродного или иностранного происходило на протяжении всего XX века, продолжается и в настоящее время.

Обращаясь к истории развития науки преподавания языка как иностранного, в целом и к истории создания Программ для студентов-иностранцев в частности, узнаем, что первоначально Программы «обладали информирующей функцией, которая заключалась в том, что любая программа сообщала преподавателям… о содержании учебного материала» [1, 168]. Со временем, с приездом в страну иностранных студентов цели и задачи преподавания русского как неродного расширились до уровня иностранного. Претерпев ряд преобразований, в Программах по русскому языку получил развитие и утвердился как основной «принцип активной коммуникативности» [1, 173]. «Коммуникативность обучения сопрягается с практическим овладением русским языком как средством мышления и общения в устной и письменной форме», - отмечено В.Г.Костомаровым. [2, 12].

Учебная программа для студентов вуза, обучающихся иностранному (русскому) языку – это элемент системы обучения, которая по структуре и содержанию отражает весь учебный процесс, направленный на работу со студентами. Содержательные и структурные элементы учебной программы изменяемы и вариативны. Они зависят от рекомендаций руководящих инстанций и соответственно от хода всего учебного процесса вуза. Например, с учетом медико-пандемийной ситуации в мире обучение в вузах приобрело помимо традиционной еще и дистанционную форму. А учебная программа получила дополнительную градацию по принципу очного и онлайн обучения, которое продолжает развиваться и приобретать свою методическую специфику. Кроме того, каждый вуз выбирает определенную систему контроля. Итоговый экзамен может быть в виде тестирования, что характерно для Азербайджанского медицинского университета, хотя существуют и иные формы экзаменационного контроля в других вузах Республики.

Учебная программа включает в себя календарно-тематические планы по одному предмету для разных категорий обучаемых, разработанные с учетом определенных требований. В учебной программе указаны цели, задачи, планируемые результаты определенных групп студентов. В этом документе указан перечень учебников, учебных пособий, наглядных материалов, методической литературы. Данная программа отражает ход учебного процесса, в то же время является руководством для каждого преподавателя в выполнении требований этого учебного процесса.

На основе учебной программы составляется Силлабус, где приводится развернутый план каждой темы каждого урока. Раскрытие каждой темы урока проводится по всем видам речевой деятельности: чтения, говорения, письма и аудирования. Каждый вид речевой деятельности содержит систему упражнений с указанием номеров и месторасположением в учебнике. Данный документ содержит конкретные и четкие рекомендации для составления поурочного плана каждого преподавателя и проведения урока с учетом конкретных целей, задач, направленных на результаты обучения студентов в целом. Умение преподавателя организовать свою подготовку к каждому уроку с учетом всех факторов и рекомендаций подробного развернутого плана (Силлабуса) должно обеспечить успешную работу хода всего учебного процесса кафедры.

Учебная программа подчинена методике преподавания того предмета, которому она предназна-

чена, и направлена на образовательные и воспитательные цели обучения, которые находятся в тесной взаимосвязи с задачами подготовки специалистов высокого класса. Образовательные и воспитательные цели могут быть реализованы лишь при условии достижения студентами определенного уровня знаний по предмету, в нашем случае, владения иностранным, конкретно, русским языком.

Рассмотрим условия учебного процесса вуза, которые должны учитываться при составлении учебной программы и силлабуса кафедры:

1. Учет распределения всех студентов по соответствующим группам в зависимости от уровня знаний предмета, от места проживания, от выбранной специальности. от сектора обучения.

2. Определение этапа обучения иностранного языка.

3. Подбор учебного материала, включая наглядность с учетом страноведческого аспекта обучения.

4. Расчет учебного времени в соответствии с учебным планом вуза.

5. Выбор методики преподавания предмета исходя из каждой отдельной категории студентов.

6. Разграничение методических целей, задач и результатов обучения каждой категории студентов.

7. Включение в силлабус развернутого материала для каждой темы, что является помощью для составления поурочных планов каждым преподавателем.

Учебные программы изучения языковых дисциплин в нефилологических вузах подразделяются на особые типы, предназначенные для различных категорий обучающихся. Эти программы имеют как общие, так и отличительные черты, непосредственно связанные с целями обучения, с объективными и субъективными условиями, в которых протекает учебный процесс. Исследователи данного вопроса к объективным условиям относят: «1) конечную цель обучения в данной группе, 2) профиль учебного заведения или профессиональные интересы группы, 3) сроки обучения и количество времени в часах, 4) этап обучения». К субъективным условиям относят: «1) возраст учащихся, 2) их лингвистическая подготовка» [5, 21].

Нами дается более подробный анализ условий учебного процесса, которые учитываются при составлении учебной программы конкретного вуза (АМУ), конкретной кафедры (иностранных языков) по конкретному предмету «Деловой и академической коммуникации на иностранном языке». В связи с этим, составление этой программы предусматривает подробное рассмотрение вышеперечисленных видов работы:

1. Учет распределения всех студентов по соответствующим группам в зависимости:

а) от продолжительности изучения языка (школа, вуз, магистратура, резидентура), а значит, от уровня знаний данного предмета. При составлении учебной программы необходимо учитывать уровень знаний учащихся. Каждая учебная программа по определенному предмету должна быть направлена определенной группе студентов, обладающих приблизительно одинаковым уровнем знаний или имеющим одинаковые условия восприятия иностранного (русского) языка.

б) от их места проживания. Все студенты подразделяются на две категории: 1) студенты, обучающиеся на родном (азербайджанском) языке и 2) иностранные студенты. Если наши студенты знакомы с фонетико-интонационным строем русского языка, то со студентами-иностранцами предстоит детальное изучение морфемного произношения и интонационных конструкций языка.

в) от выбранной ими специальности. Студенты вуза обучаются по следующим специальностям: В вузе обучаются как студенты-медики, резиденты по всем видам медицинских специальностей, магистры по определенным видам специальностей, военные фельдшеры. Составление учебной программы в зависимости от будущей специальности тесно связано с наличием учебников.

г) от цели изучения языка и выбора сектора обучения студентами. Учебная программа по предмету «Деловой и академической коммуникации» на русском языке составляется для студентов, магистрантов и резидентов азербайджанского сектора, а также для иностранных студентов английского сектора первого курса и русского сектора подготовительного факультета. Такое разнообразие категорий студентов, безусловно, предусматривает разные учебные программы и силлабусы.

2. Определение этапа обучения иностранного языка в зависимости от продолжительности изучения предмета данной категорией студентов. Этапы обучения русского языка как иностранного исследуются в методической литературе и имеют различную градацию. Градация этапов при обучении русского языка как иностранного величина непостоянная. Разные школы методической науки выдвигают свои схемы этапов изучения иностранного языка как неродного. Нами выбрана схема следующих этапов: начальный (нулевой), элементарный (или средний), продвинутый.

3. Подбор учебного материала, включая наглядность с учетом страноведческого аспекта обучения. Любая работа над учебной программой начинается с выбора учебного материала. При подборе учебников необходимо соответствие учебной программы для определенной категории студентов с общей централизованной Программой по предмету (по русскому языку). Используются учебники, составленные непосредственно преподавателями вузов с адаптацией на страноведческий материал страны. Большой выбор учебников, учебных и наглядных пособий предоставлен для работы с иностранными студентами. При использовании учебников, составленных компетентными преподавателями из разных стран, необходим дополнительный страноведческий материал, основанный на современных реалиях Азербайджана.

Учебный материал для студентов в определенном вузе должен учитывать специальность данного высшего учебного заведения, в нашем случае, Азербайджанский медицинский университет, где готовят врачей-медиков. В учебниках и учебных пособиях содержится материал по научному стилю

речи для наших студентов. При обучении иностранных студентов материал представляет собой дополнительные к основному курсу обучения учебно-практические пособия по естественным дисциплинам. Материал пособия соотнесен с учебной программой как в плане лексико-грамматического наполнения, так и в плане требований к уровню владения основными видами речевой деятельности.

4. Расчет учебного времени по предмету в соответствии с учебным планом вуза. Любая учебная программа представляет собой планирование учебного процесса, рассчитанного на определенное количество учебных часов. Чтобы за отведенное время достигнуть нужных результатов, необходимо тщательно отобрать учебный материал в зависимости от цели обучения и четко распределить его по часам, т.е. организовать всю учебную работу по плану. Данное условие зависит от Учебного плана вуза и связано с работой над составлением календарно-тематического плана учебной программы. Определенная трудность, связанная с расчетом часов при составлении календарно-тематического плана, заключается в том, что на каждый семестр отводится разное количество часов. Так, разное количество часов в первом и во втором семестрах на разных факультетах приводит к двойному стандарту одного и того же вида календарно-тематического плана.

5. Выбор методики преподавания предмета исходя из каждой отдельной категории студентов. «Методика обучения иностранным языкам – наука, исследующая закономерности, цели, содержание, средства, методы, приемы и системы обучения, а также изучающая принципы учения и воспитания на материале иностранного языка» [4, 12]. Данное определение методики как науки предусматривает наличие образовательной и воспитательной составляющих при обучении иностранному языку. В данном контексте особую значимость приобретает коммуникативная направленность обучения, которая обуславливает весь образовательный процесс. Кроме того, вся система практических заданий и упражнений, отраженных в силлабусе, должны быть максимально схожи с обычным речевым общением в типичной жизненной ситуации. По мнению исследователей, «обособленность грамматики в обучении приводит к непроизводительным затратам времени, к принижению ее роли в учебной коммуникации… Обучение языку и речи вне задач общения приводит к разрыву между лексико-грамматическим материалом и реальными коммуникативными потребностями учащихся…» [3, 49-50].

Воспитательная работа рассматривается с учетом страноведения. Аспект страноведения принимает на себя также информативную функцию, что особенно важно для иностранных студентов, обучающихся в незнакомой стране. Информирующая составляющая воспитательного процесса знакомит студентов с современными и историческими реалиями той страны, где они живут и учатся в настоящее время.

6. Разграничение методических целей, задач и результатов обучения каждой категории студентов. Название предмета «Деловая и академическая коммуникация на иностранном языке» по выбору учащегося предусматривает ведущую роль коммуникативной направленности в системе обучения иностранному языку. Понятно, что любая тема урока, например грамматическая, должна вводиться не обособленно, а в контексте, с обязательным указанием на употребление данной темы в речи. Роль коммуникативного метода обучения возросла в связи с современной концепцией методической науки, что необходимо учитывать при составлении учебной программы. При обучении дисциплине «Деловой и академической коммуникации на иностранном языке» особое внимание следует уделить привитию навыков устной и письменной речи студента при деловом и академическом общении, как в разговорном, так и в научном стиле речи, как устного, так и письменного изложения мысли на одном из иностранных языков. Таким образом определяются и результаты обучения студента иностранному языку:

а). В процессе обучения студент приобретает умения готовить презентации по специальности на одном из иностранных языков.

б). В повседневной жизни овладевает свободным общением на иностранном языке.

в). В профессиональной деятельности осваивает навыки общения на иностранном языке.

г). Познает особенности делового и академического письма, осваивает навык составления текстов на различные темы.

д). Распознает содержание и структуру академического и делового стиля речи и использует эти знания в общении.

Надо отметить, что данные рекомендации по результатам курса обучения, в основном, предназначены для той категории студентов, которые обладают определенными знаниями изучаемого иностранного языка, например, после школьного курса обучения и имеют опыт коммуникации в языковой среде, пусть даже с минимальной конструктивностью. Для иностранных же студентов, начинающих изучать язык как иностранный с фонетических морфем, присущи цели, задачи и результаты иного характера, исходя из различной методики преподавания иностранного языка как неродного, в данном случае русского. Выполнение этой рекомендации тесно связано с наличием различных этапов в методике преподавания неродного языка.

7. Включение в учебную программу развернутого материала для каждой темы по всем видам речевой деятельности: чтению, говорению, аудированию и письму является помощью для составления поурочных планов или конспектов каждым преподавателем. Данный вид работы является практическим аспектом педагогической деятельности.

Заключение

Таким образом, процесс обучения русскому языку в университете подчиняется достижению основной цели методики преподавания – практическому овладению данным языком студентами. В

программу включены языковые материалы, состоящие из лексического минимума, необходимого для усвоения основных видов речевой деятельности: чтение, письмо, говорение, аудирование. Каждому виду речевой деятельности отводится определенное место в системе преподавания русского языка, что отображено в учебных документах кафедры, таких как учебная программа, силлабус, календарно-тематический план. Практическое овладение иностранным языком предусматривает формирование устной и письменной речи, осмысление читаемой литературы по специальности, письменное изложение любой мысли и постоянное совершенствование полученных речевых умений. С целью развития и совершенствования речевых навыков русского языка содержание активного и дополнительного лексического материала для учебной программы выбирается соответственно с общественно-деловой и профессионально-академической деятельностью студента как будущего специалиста. При составлении учебной программы, кроме соблюдения правил методики, необходимо учитывать все условия учебного процесса. Ибо каждая учебная программа по определенному предмету должна обладать четкой направленностью той или иной категории студентов и содержать в себе все требования современной методики.

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STRATEGİC PLANNİNG OF STUDENT ACTİVİTY İN EDUCATİON

Abdullayeva M.
Doctor of Philosophy in Pedagogy, Associate Professor
Azerbaijan State Pedagogical University, Faculty of Mathematics
Department of Mathematics and its teaching technology, Baku
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Abstract

This article examines the strategic planning of activities to support the professional development of students in education. In the era of the Fourth Industrial Revolution, individuals are required to possess not only knowledge but also advanced skills and competencies that enable them to adapt to rapidly changing social, technological, and professional environments. Education plays a pivotal role in cultivating these competencies, as today's students represent the specialists and professionals of the near future. The demands of the modern era pose various challenges for students, including how to effectively manage their time, organize their learning activities, and continuously develop their knowledge, skills, and creative potential. In addition, fostering the personal and professional growth of students requires attention to both intellectual and practical aspects of learning, ensuring that students acquire the ability to think critically, solve problems independently, and engage in meaningful educational and social projects.

The primary purpose of this study is to investigate the impact of activity planning on the professional development of students in higher education. The research examines the opinions of university students regarding their ability to organize, manage, and implement educational and extracurricular activities, and draws conclusions based on data collected through a descriptive quantitative research method. By identifying the challenges students face in managing their time and activities, this study emphasizes the importance of structured planning as a tool for achieving academic and professional goals. Furthermore, the findings aim to provide practical guidance for students, enabling them to enhance their learning efficiency, cultivate creativity, and achieve successful outcomes in their professional development.

Keywords: planning in education, student activity, time management, professional development, educational strategy, academic success

Introduction

Education plays a pivotal role in advancing scientific and technological progress worldwide. It must prepare specialists capable of managing the future—individuals who can predict events through imagination, critical thinking, and intuition, foresee solutions to problems, and implement them effectively. In other words, education must cultivate the "person of the future," as former U.S. President John F. Kennedy described: "…people who wish for what never was…"

The Law of the Republic of Azerbaijan "On Education" emphasizes the development of personalities with high moral and civic values. The main objectives of education are:

- To cultivate citizens who are aware of their responsibilities to the Republic of Azerbaijan, respect national traditions and democratic principles, uphold human rights and freedoms, demonstrate patriotism and loyalty to Azerbaijani ideals, and think independently and creatively.
- To prepare specialists who protect and advance national, moral, and universal values, possess a broad outlook, can evaluate innovations and initiatives, acquire both theoretical and practical knowledge, and remain competitive in modern society.
- To ensure the systematic assimilation of knowledge, skills, and habits, continually enhance qualifications, and prepare students for active social engagement and effective professional activity (Law on Education of the Republic of Azerbaijan, 2009).

Technological and scientific developments increasingly necessitate educational innovation. Developing countries, in particular, require a highly skilled workforce to keep pace with global advancements and achieve development goals. Education is a key factor in shaping such human capital, and nations invest significantly in improving educational quality to ensure sustainable progress.

Teacher education is central to these efforts, as teachers play a crucial role in shaping future generations. Today's students in higher pedagogical institutions—the future educators—must actively develop their intellectual, cultural, and professional capacities to meet the challenges of rapidly evolving educational and societal contexts. They must engage in continuous learning, research, and skill development, integrating knowledge into practical and innovative solutions.

The document "Azerbaijan 2030: National Priorities for Socio-Economic Development" (President of the Republic of Azerbaijan, 2021) underscores the strategic importance of human capital. One of its five priorities, "Competitive human capital and modern innovation space," highlights the role of education in fostering a creative and innovative society capable of thriving in global competition.

Amidst the Fourth Industrial Revolution, various public-private initiatives and projects have emerged to equip individuals with essential skills. The 2020 World Economic Forum meeting emphasized education reform through the "Reskilling Revolution Platform," aiming to provide one billion people worldwide with new competencies by 2030 (Bashirov, 2020).

The COVID-19 pandemic accelerated educational innovation, prompting widespread adoption of online training, webinars, and other professional development activities. Students and educators are now expected to participate actively in daily learning, acquire digital literacy, solve practical problems, and apply modern technologies. These efforts are essential not only for professional growth but also for shaping the "person of the future."

However, several questions remain: Are our current pedagogical programs adequately preparing students to educate future generations? Are students actively engaging in projects and activities that enhance their competencies? How effectively can educational institutions adapt to technological transformations while maintaining high-quality human capital development?

Thus, to address these questions, a survey was conducted among students to assess their perspectives and experiences. The research was carried out in March 2021, providing insights into the current state of student engagement and preparedness.

Addressing these questions is essential for strategic planning of student activity in education, ensuring that future specialists are equipped to meet the demands of a rapidly evolving world.

Purpose of the Research

The purpose of this study is to determine the impact of activity planning on the professional development of students in education. The research focused on the opinions of students in a higher pedagogical school, and conclusions were drawn based on the collected data. A descriptive quantitative method was employed for this research.

Problem and Research Question

Research question: How do students ensure their professional development in education?

To answer this question, a survey was conducted among 130 students, including 19 male and 111 female participants. The survey consisted of a questionnaire with three questions:

Question 1: Are you able to perform the tasks provided by the syllabus on time?

1. I can hardly perform it
2. I partially perform
3. I perform to a certain extent
4. I fully perform

Question 2: Do you participate in educational projects?

1. I do not have enough time
2. I attend occasionally
3. I try to find time for participation
4. I always attend

Question 3: Do you participate in the social life of your university?

1. I do not have enough time
2. I participate occasionally
3. I participate when I have time
4. I always attend

The survey results are summarized in the table below:

The survey results are listed in the table.

№	Responses / Questions	1	2	3	4
		Number of students by number (in %)	Number of students by number (in %)	Number of students by number (in %)	Number of students by number (in %)
1	Are you able to perform the tasks provided by the syllabus on time?	10 (7,7%)	71 (54,7%)	30 (23%)	19 (14,6%)
2	Do you participate in educational projects?	39 (30%)	54 (41,6%)	25 (19,2%)	12 (9,2%)
3	Do you participate in the social life of your university?	27 (20,8%)	53 (40,8%)	34 (26,1%)	16 (12,3%)

Findings

The survey revealed that:

- **7,7%** of students could not complete the tasks given in the syllabus on time, while **14,6%** were able to complete them fully.
- **30%** of students did not participate in educational projects, and only **9,2%** always found time to participate.
- **20,8%** of students did not participate in the social life of the university, whereas **12,3%** actively participated.

These findings indicate that students face significant challenges in developing their professionalism. According to the students, the main reason for these difficulties is insufficient planning of their educational activities. Proper organization and strategic planning of student activity are, therefore, crucial for enhancing professional development.

Conclusion and Recommendations

Students in higher education are being prepared for professions they may have little prior knowledge of and have never practically experienced. Therefore, they must not only understand the ideas presented during the learning process but also develop the ability to generate new and creative ideas. Lessons should address students' needs and reveal their potential. How students comprehend and respond to the ideas they encounter, as well as their capacity for creative thinking, reflects their level of future professionalism.

In the educational process, it is essential to allocate time for students to think critically and participate in discussions. This consideration should be integrated into lesson planning; otherwise, the content delivered may not have the desired impact. Modern and strategic planning approaches are therefore necessary. When

teachers implement such strategies, students are encouraged to become active, self-motivated learners who seek ways to develop their skills independently. An active student will recognize gaps in their knowledge, which fosters purposeful and well-planned engagement.

What is planning?

Planning is the process of goal formulation and the concretization of methods, measures, and resources to achieve those goals. The outcome of planning is a concrete plan - a structured model of action. Effective planning requires forecasting, also referred to as foresight. Long-term forecasting serves as the foundation of social and strategic planning. However, the rapid and synergistic development of today's world complicates accurate prediction.

The essence of planning lies in defining strategic goals and tasks, making operational and strategic decisions, determining methods for achieving objectives, allocating duration and resources (material, financial, labor), and assigning responsible persons. Planning establishes a link between the current state and the desired future state while answering critical questions: *What should be done? When should it be done? Who is responsible for it?* (Ahmadov, 2013).

Based on the findings of this research, it can be concluded that students must properly plan their time to ensure professional development in education. Timely completion of tasks and effective use of time are essential for achieving goals. It is impossible to become a high-quality teacher, doctor, engineer, or future-ready professional without structured and purposeful activity.

Futurist Alvin Toffler emphasized that the functions of education in the near future have evolved. He defined illiteracy in the era of the Fourth Industrial Revolution not as the inability to read or write, but as the inability to *learn, unlearn, and relearn* (Israfilov, 2018). This perspective underscores the importance of planning, adaptability, and continuous professional development for students in education.

Proposals

In this context, training programs that support the professional development of students should be systematically organized. Methodical materials must be prepared, and students should be actively involved in various research publications. Furthermore, each student should be able to independently monitor and control their learning activities, and this progress should be reportable.

Students can plan their educational activities effectively by considering the following steps:

- **Define learning goals:** Clearly identify what you aim to achieve in each learning activity.
- **Create a plan for each task:** Organize a structured approach to every assignment or project.
- **Clarify learning objectives:** Specify what knowledge or skills you want to acquire.
- **Allocate time effectively:** Set realistic timeframes for each task or activity.
- **Stimulate motivation and creativity:** Set goals that increase interest and encourage critical thinking.
- **Plan targeted learning activities:** Design tasks that directly contribute to achieving your objectives.
- **Adapt the plan to your needs:** Customize your approach based on your strengths and areas for improvement.
- **Develop strategies:** Determine *what* to do and *how* to accomplish it.
- **Conduct research and gather resources:** Read books, watch relevant videos, and create a knowledge database.
- **Review and refine the plan:** Continuously evaluate your progress to ensure efficiency.
- **Prioritize important tasks:** Identify key activities and focus on executing them.
- **Maintain resilience:** Be patient, confident, determined, and persistent, even in the face of failure.
- **Work diligently:** Apply consistent effort and dedication, understanding that perseverance leads you closer to your goals.

Implementing these strategies will enable students to actively plan, manage, and enhance their professional development, ensuring that they are well-prepared for the challenges of the future.

Conclusion

Planning is the deliberate and systematic preparation of work in advance. It is a social skill, not innate, that is developed and refined through education.

A student must clearly define their educational goals: what should be studied during class, what can be studied independently after class, and which tasks have higher priority. This requires thoughtful decision-making and effective time management. Strategic planning plays a critical role in managing time efficiently. A student who applies action planning demonstrates greater sophistication and reliability in solving tasks. By preparing a structured plan, it becomes possible to determine the most rational methods for achieving targeted goals and successfully reaching desired outcomes.

Maye Musk, the mother of Elon Musk, the second richest person in the world, reflects on her experience of success: *"You have to make a plan to successfully get out of the twists and turns in life. If you do not want to be disappointed, you need to plan. If a plan is not working, the plan needs to be changed. This is a requirement of life."*

In all areas of life, including education, success can be achieved by planning each task carefully. Proper planning of educational activities is the most effective way to achieve learning objectives and foster professional development.

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AUTHENTIC ENGLISH COMMUNICATION SKILLS OF 10TH-11TH GRADE STUDENTS

Kismetova G.,
Candidate of Pedagogical Sciences,
Associate Professor, Teacher, M.Utemisov West Kazakhstan University, Uralsk, Kazakhstan
Saktaganova A.
Master's degree student, Khalel Dosmukhamedov University, Atyrau, Kazakhstan
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Abstract

This article analyzes the development of authentic English communication skills in 10th- and 11th-grade students. It examines the fundamentals of authenticity and linguodidactics, as well as its importance for the development of schoolchildren's communicative competencies. The study identified motivational and psychological characteristics of high school students that can influence the process of mastering language interaction. Effective methods, such as communication-oriented, project-based, and situationally relevant, were also described. Practical forms of work designed to develop natural speech activity, such as discussions, mini-projects, online interaction, and media practice, are presented. Particular attention is paid to assessing the level of authentic communication. The results identify key challenges and solutions.

Keywords: authentic communication, English language, communicative competence; intercultural communication and speech development.

INTRODUCTION

Today, globalization and the development of digital technology significantly impact the demand for high levels of English proficiency among schoolchildren. Consequently, this underscores the importance of developing authentic communication skills, or more precisely, the ability to use language in real life, not just on the walls of schools. Therefore, developing authentic communication skills that enable real-life use of language is becoming increasingly important. It will be especially important for high school students in grades 10 and 11 to apply these skills, as they will be expected to use English in their studies after school. Particularly in intercultural interactions where different countries and nations are represented, communication skills in everyday life will be sorely lacking [1].

In foreign language teaching, the term "authentic communication" refers to the use of authentic materials, natural language patterns, and scenarios that mimic real-life communication. In contrast to staged dialogues, which are often formal and do not reflect an authentic communicative environment, authenticity requires dynamic, spontaneous speaking, cultural context, and realistic communication tasks. This method is closely linked to communicative and action-oriented approaches, where learning is based on using language to communicate, solving speaking problems, and actively participating in speaking activities [2].

The aim of this article is to describe the characteristics of the development of authentic communication skills in secondary school students and to investigate the methodological factors that promote their development. The following objectives were formulated in accordance with this aim:

– to Highlight the qualities of authentic communication and how they are applied in contemporary English language teaching;

– to identify the main barriers to students learning authentic communication and suggest ways to overcome them.

– To explore teaching methods and best practices.

METHODOLOGY

One of the most commonly used methods in teaching foreign languages today is the communicative approach. It aims to develop both effective communication skills and a solid understanding of grammar. This approach is based on the principle of active interaction. Learners work in groups or pairs, engaging in conversations, discussions, and interaction while addressing realistic language situations. Instead of memorizing forms, this approach focuses on the communicative task and the meaning of the statement. In this way, learners learn to use language not only as a subject but also as a means of communication[3].

With the project-based approach, learners can tackle more challenging communicative tasks, such as presentations, interviews, surveys, research projects, or media projects. These require extensive lexical and linguistic activity, preparation, discussion, and teamwork. Students are usually faced with real-world problems. Therefore, in these projects, they can learn to reason, express their thoughts, and interact in English. There are also various options for group and individual work. Especially when topics are chosen according to students' interests, this approach fosters a sense of responsibility, independence, creativity, and motivation [4].

Interactions in business, at the airport, encounters with new people, organizing a trip, negotiations, and other real-life situations can be effectively simulated through role-playing and simulations. Students can use the language independently, respond to unexpected signals, practice giving instructions and tactics, conduct role-playing exercises, and train their communication skills. This promotes skills such as quick reflexes, adaptability, sociocultural flexibility, and reduces anxiety about speaking. This approach is particularly helpful in improving confidence and fluency.

Students experience authentic English as spoken by native speakers through original materials such as

music, interviews, podcasts, media reports, dialogues, and video clips. They learn modern idioms, colloquialisms, intonation, speech styles, and cultural nuances. This reduces the gap between classroom models and reality. Authentic resources stimulate interest and motivation, while also promoting the development of listening, reading, comprehension, and contextual interpretation skills, as they cover topics, lives, and cultures that are relevant to students [5].

Interactive technologies such as computers, multimedia, online platforms, video chats, and social networks can provide additional opportunities to create the most realistic language learning environment possible. These include completing multimedia tasks, group projects, virtual tours, online correspondence, and video chats. These teaching strategies enable learners to actively use the language, interact with classmates or native speakers, exchange information, and participate in global communication – rather than simply observing it. Interactivity also increases motivation, facilitates individualized learning, self-paced learning, content repetition, and the use of diverse media resources. All of this is crucial for the development of all communication skills, including speaking, listening, reading, and writing [6]. Useful methods for working with high school students:

1. Realistic conversation scenarios. Students engage in conversations about news, career opportunities, school activities, and topics relevant to teenagers and their everyday lives. By using everyday expressions and idioms, they develop natural communication skills.

2. Familiarity with communication techniques. This focuses on strategies such as asking questions, clarifying, expressing agreement or skepticism, conducting short conversations, and arguing in discussions. These skills foster persuasive communication and dynamic communication.

3. Short conversations and debates. Short conversations and debates help develop a logical conversational structure. Linguistic clichés are used to express viewpoints and respond to others' arguments.

4. Media production. Students can practice oral communication, expand their vocabulary, and use language creatively through podcasts, video blogs, interviews, and group discussions.

5. Use of social media. Participation in international online initiatives, commenting on publications, and engaging in safe, ethical online interactions all contribute to improving written and oral communication skills in real-life communication situations.

RESULTS

Eleventh-grade students participated in an eight-week study to evaluate the effectiveness of various techniques for developing authentic communication skills. During the experiment, about thirty students were divided into experimental (group B) and control (group A) groups. Control Group A used textbooks and conventional assignments, consisting mainly of conversation and grammar exercises, and aligned with the standard curriculum.

Experimental Group B used a number of original methods such as role-playing and simulations, project work, the use of real materials, and the involvement of external resources such as language clubs and global online discussions. The communication-oriented structure of the lessons, adapted to pedagogical principles, allowed for more time to practice speaking. Pre and post tests, assessments of oral communication skills, participation in discussions, short debates, and project work were all part of the experiment.

In addition, the students' confidence in their English language skills and their understanding of real-world topics were assessed using Likert scales. The impact of real-world approaches on the development of communicative skills and students' enthusiasm for active speaking was demonstrated by comparing the results of the control and intervention groups.

The Likert scale was used to assess how well the students developed their authentic communication skills and how they perceived the lessons. Subjective indicators can be measured quantitatively on a five-point scale: 1 represents "strongly disagree," 2 represents "disagree," 3 represents "neutral," 4 represents "agree," and 5 represents "strongly agree." The students in the control and intervention groups completed questionnaires before and after the experiment, allowing for the evaluation of the dynamics of change.

Table 1.

Comparative results of the development of authentic communication skills

Skill/Problem	Solving Methods	Group A		Group B	
		before	after	before	after
Lack of live practice	International chats, language clubs, online meetings	3.2	3.4	3.3	4.2
Time constraints	Integration of authentic tasks, flipped classroom	3.0	3.3	2.9	4.0
Psychological barrier	Creating a positive atmosphere; mistakes as part of the process	2.7	3.0	3.1	4.2
Lack of authentic materials	Media, adapted resources	3.2	3.5	3.3	4.3

DISCUSSION

The communication skills of high school students were significantly improved through the introduction of authentic methods and formats, as the analysis of the collected data shows. Group B achieved significantly higher average scores than the control group in the areas of direct communication, overcoming psychological barriers, utilizing real-world resources, and productive use of learning time.

The average score of the experimental group (4.2) regarding lack of practical experience was significantly

higher than that of the control group (3.4). This underscores the value of online meetings, language clubs, and international conversations. It suggests that access to a real-world language environment boosts students' confidence and motivates them to actively participate in language activities.

Time constraints: The practice group achieved an average score of 4.0 compared to 3.3 in the control group. This is attributable to the integration of real-world tasks into each phase of instruction and the use of the translated classroom concept. This result demonstrates that the productivity of language communication is increased through organized preparation outside the classroom and the staggered distribution of activities.

Psychological Hurdle: The experimental group achieved an average score of 4.2, while the control group only achieved 3.0. This suggests that a safe and encouraging learning environment, in which mistakes are accepted as a necessary part of the learning process, reduces students' anxiety and promotes fluency.

The average score rose to 4.3 when media resources, adapted texts, and videos were available, while the control group scored only 3.5. This demonstrates how the use of diverse authentic sources significantly improves the understanding and application of the native language.

Overall, the results of the experiment show that secondary school students can acquire comprehensive communicative skills comparable to everyday English use through the integrated use of authentic teaching methods, external resources, and a psychologically safe learning environment. The control group, which worked with conventional textbooks and standard tasks, performed worse, highlighting the need for methodological adjustments in secondary school foreign language teaching.

CONCLUSION

The study has shown that orienting English language teaching in grades 10^{th}-11^{th} toward authentic foreign-language communication is an effective means of preparing secondary school students for real-life situations. Factors that promote readiness to use language in practice include the use of real-world materials, role-playing, and project-based learning methods. These methods are communication-focused and therefore significantly improve students' language proficiency.

The integrated application of authentic methods ensures a higher level of students' participation in communicative interaction, reduces psychological barriers, and optimizes the use of lesson time by prioritizing meaningful language practice over purely formal drill of language items. Finally, it can be understood that, as a result of the experiment with control and experiment, it was proven that with targeted pedagogical support, senior secondary school students can successfully acquire practical communication skills that will develop support and initiative skills.

We can see that, according to the results, authentic communicative actions not only contributed to the development of language skills but also formed sociolinguistic, discursive, and strategic components. Communicative competence is essential for effective interaction in a globalized world. An important factor in this effectiveness is the systematic use of external resources (authentic media, online materials, intercultural contacts) and the creation of a supportive learning environment that allows for linguistic risk-taking and encourages learner initiative.

Particular attention should be paid to formative assessment based on projects, presentations, role-plays, and portfolios. These real-world tasks allow for the assessment of students' proficiency in other language skills and their actual communicative behavior. Results have shown that the systematic integration of authentic materials into the high school curriculum ensures the transfer of acquired skills beyond the classroom, shaping future education and everyday communication. Thus, the proposed approach can be considered a key condition for developing communicative competence that meets the demands of modern society.

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PHILOLOGICAL SCIENCES

NEFʿÎ AND HIS POETIC WORLD IN 17TH-CENTURY CLASSICAL TURKISH LITERATURE

Rahimova L.
Ph.D., Assoc. Prof.
Institute of Manuscripts named after Muhammad Fuzuli, ANAS
Azerbaijan, Baku
Orcide:0000-0003-0952-4452
https://doi.org/10.5281/zenodo.18070639

Abstract

Although the seventeenth century in the Ottoman Empire was marked by political and social crises, it constituted a highly productive and rich period in terms of Classical Turkish literature. During this era, Divan poetry not only continued its established tradition but also gained new stylistic and expressive dimensions. One of the most prominent and innovative poets of the period was Nefʿî. This article examines Nefʿî's life, literary personality, and the main characteristics of his poetic output. Particular attention is paid to his mastery of the qasida genre, the innovations he introduced in language and style, and his poetic world distinguished by strong self-confidence and a pronounced spirit of self-praise (fakhr).

At the same time, the controversies surrounding Nefʿî's satirical work Sihām al-Qażā, its aesthetic value, and its position within Divan poetry are analyzed from a critical literary perspective. By drawing on the views of both classical and modern scholars, the article offers a comparative evaluation of Nefʿî's artistic skill in both panegyric and satirical poetry. In conclusion, it is argued that Nefʿî's oeuvre played a significant role in the development of seventeenth-century Classical Turkish literature and that his poetry is also of considerable importance for the study of Azerbaijani–Turkish literary relations.

Keywords: Turkish poetry, Ottoman sultans, Nefʿî, Azerbaijani, literary

Introduction

Although the seventeenth century in Ottoman history is generally evaluated as a period of political and economic crises, from a literary perspective, it is regarded as one of the most productive and brilliant phases of classical Turkish poetry. During this period, Ottoman sultans not only patronized artists but also personally produced works in poetry and other fields of art. Ahmed I, who composed religiously themed poems under the pen name "Bahti", Osman II (the Young), known by the pen name "Farisi," meaning "master rider", Murad IV, who wrote under the pen name "Muradi", and Mehmed IV, known by the pen name "Vefayi," were all recognized both as rulers and as poets. In seventeenth-century Ottoman poetry, alongside poets who continued the poetic traditions of earlier periods, there were also poets who produced works under the influence of the **hikemî** (didactic) style, **Sebk-i Hindî** (the Indian style), as well as the trend of **mahallileshme** (localization or vernacularization). In the sources, the poetry of this century is classified into four main directions: the followers of Bâkî's style; those in search of new stylistic approaches; representatives of the **hikemî** and **mahallî** styles; and the exponents of Sufi poetry.

Main part

One of the most prominent figures representing the innovative trend in seventeenth-century classical Turkish literature is Nefʿî. This powerful poet, known by the pen name "Nefʿî," bore the given name Ömer. Although sources indicate that he was born in Hasankale, located approximately 40 kilometers from Erzurum, there is no precise information regarding his year of birth. Nevertheless, scholars have concluded that the poet was likely born around 1572.

In substantiating this date, Abdülkadir Karahan draws attention to Nefʿî's statement in a qasida addressed to Hafız Ahmed Pasha in 1034 AH (1625 CE), in which the poet notes that he had been writing poetry for "thirty years." At the same time, Karahan's discovery that Gelibolulu Mustafa Âlî, in the introductory section of his work Mecmaʿü'l-bahreyn (1000 AH / 1591 CE), refers to Nefʿî as "a young and intelligent poet" further strengthens this assumption. Relying on these pieces of evidence, Karahan considers it more plausible that Nefʿî's birth date corresponds to the years mentioned above.

Relying on a manuscript found in Raif Yelkenci's book collection, Karahan notes that Nefʿî's father was Mehmed Bey and his grandfather Ali Pasha, and he further states that the poet's lineage traced back to Shirvan. Although Nefʿî initially used the pen name "Darîr," meaning "afflicted by harm," we understand from a qasida with the refrain (redif) "Sühan" that, upon the recommendation of Mustafa Âlî, he later changed this pen name.

Eyledüm mahlas-ı Nefʿî ile kadrüm efzûn,
Zihn-i pâkimde görüp kuvve-yi îzân-ı sühan. [2,207]

(I have enhanced my esteem by adopting the pen name Nefʿî, perceiving in my pure mind the power of understanding in eloquent expression.)

It can be said that she did not have a very prosperous childhood, based on the words of the poet who satirized her father, who left her when she was still a child and went to be a bridegroom to the Crimean Khan:

Saadet ile nedîm olalı pedêr khanâ,

Ne mercimek görer oldu gözüm ne tarhâna.
.....
Pedêr değil bu belây-i siyyehdir başıma,
Sözüm yerinde nola güç gelirse ger khanâ. [2, 46]

In the early phase of his literary career, Nefʿî was influenced by Persian classical poets such as Hafez and Sa‘dî. Although the exact time and reasons for his arrival in Istanbul are not entirely clear, it is known that he lived in the city for approximately thirty years. He maintained close ties to the palace during the reigns of Ahmed I and Murad IV, and particularly under Murad IV’s rule, he both gained significant influence and was ultimately driven to a tragic end.

Murad IV’s stern character provided the context for both Nefʿî’s panegyrics and his sharp satires. However, due to the discontent caused by his work Sihâmü’l-qezâ, the poet was distanced from the palace and, later, as a result of another satire he composed, he was strangled to death in 1635.

There is insufficient information regarding the poet's early years. Even the exact time and reasons for his arrival in Istanbul remain unclear. However, based on sources, it can be stated that he lived in Istanbul for nearly thirty years. The poet lived during the reigns of Ahmed I, Mustafa I, Osman II, and Murad IV, but he held affection only for Ahmed I and Murad IV.

He composed eight qasidas for the first and twelve for the second, thereby earning their respect. He also wrote qasidas for the grand viziers of the century Quyucu Murad Pasha (d. 1020 AH), Nasuh Pasha (d. 1023 AH), Damat Mehmed Pasha (d. 1029 AH), and Khalil Pasha (d. 1040 AH) and received due honor from each of them. The most brilliant years of Nefʿî’s life and art coincided with the reign of Murad IV; unfortunately, this period also encompasses the sorrowful and tragic phase of his life. Since Murad IV himself occasionally composed poetry, he consistently valued poets highly and invited them to various gatherings. Nefʿî was among the poets who attended these assemblies. By nature, Murad IV possessed a stern and somewhat passionate temperament. It was precisely because of this characteristic that he eagerly listened to and enjoyed both Nefʿî’s panegyrics and his satire-filled verses. It should be noted here that Murad IV even had a poem dedicated to praising Nefʿî.

Gelin insaf edelim, fərq edelim miqdarı,
Şairiz biz deyu, laf ü güzafı koyalım.
Edelim bi-meze söz söylemeden istiğfar,
Daməni-Nefî-i-pakîze-êdayı tutalım.
Biz kelâm nakliyiz nerde o sâhib-güftar,
Ona teslim edelim emrine münkaad olalım. [6,7]

(Let us act justly and discern the true value of words. Rather than claiming ‘we are poets’ and speaking empty or trivial phrases, let us express ourselves with measured and respectful language. Let us take as our model the pure and refined style of Nefʿî. We are merely transmitters of words; the true author is Nefʿî, and we should submit to his command and show due respect to his expression)

However, these prosperous and happy days came to an end on June 24, 1630. According to tradition, while Murad IV was seated in his father Ahmed I’s palace in Beşiktaş, reading Nefʿî’s *Sihâmü’l-qezâ* and feeling deeply inspired, a lightning bolt struck near the throne. Interpreting this as an ominous sign, the sultan tore the work to pieces. Nefʿî was then summoned and admonished not to compose satire again. Following this incident, Nefʿî was dismissed from his post. In fact, this event is even referenced in the verses of a poet who composed a satire about Nefʿî:

Gökden nazir eindi Sihâmü’l-qezâsına,
Nefî dili ile uğradı hakkın belâsına. [6,8]

There are several accounts in the sources regarding Nefʿî’s death. According to tradition, the poet, having failed to keep a promise made to the sultan, composed a satire against Grand Vizier Bayram Pasha. As a result, Murad IV handed him over to Bayram Pasha, effectively signing his death warrant. The poet was strangled to death, and his body was subsequently thrown into the sea. Several dates of Nefʿî’s death have been recorded using the abjad (numerical) system. “Keçdi Sihâmü’l-qezâ, qatlına oldu səbəb hêcvî hâlâ Nefînin.” (*Sihâmü’l-qezâ* passed, and the cause of his execution was still Nefʿî’s satire.), “Nagahan geldi bir eksikli dedi tarihin, ah kim kıydı felek Nefî kîmi üstad’a” (Suddenly, history noted a deficiency - ah, who has struck down a master like Nefʿî?)

Based on all these dates, it can be stated that the poet was killed in 1044 AH / 1635 CE. Information about Nefʿî’s life and works is available in various sources. In all these source particularly in the writings of Katib Çelebi (1608–1657), the *tezkire* author Rıza (Seyyid Mehmed, d. 1671), Ziya Paşa (1825–1880), Recaizade Mahmud Ekrem (1847–1914), and Tofik Fikrət (1867–1915)—Nefʿî’s skill in composing qasidas and satires is emphasized, and it is noted that he brought a fresh, original language and style to these genres. His fellow poets, including Sabri (d. 1648), Naili (d. 1666), Nabi (1642–1712), Nedîm (d. 1730), and Şeyh Gâlib (1757–1799), also acknowledged Nefʿî as a powerful poet. “The poet’s mastery of poetic technique is particularly striking. It is difficult to find a poet who could so completely subjugate meter and rhyme to his emotions” [6, 13].

Referring to Ali Ekrem Bolayır, Karahan also recognizes in Nefʿî’s work the power to create both exaggeration and harmony in poetry. In his poems, Nefʿî successfully expresses the battlefields of war, his love for arms and horses, the beauty of spring, heroism, as well as the pleasures of love and wine. Among poets, it was Nefʿî who devoted the most attention to the fahriye (praise) section of the qasida. In a qasida addressed to Ahmed I, the poet’s strong sense of self-confidence becomes particularly evident.

İltifât et şuhân erbâbına kim anlardır,
Medhi-şahânı-cahan-bana veren ünvandır,
Kim bilirdi şu‘ara olmasa ger sabıkda,
Dehre devletle gelip yine giden sultanı
Haşre dek âbı-hayâtı-suhânı-Bâkîdir,
Andırıp zinde kılan namı-Süleyman Hânı.

This passage emphasizes the enduring value of poetic expression (suhân) over temporal power, highlighting the poet’s role in immortalizing rulers and history through praise.

Nefʿî was sometimes so immodest that he compared himself to renowned poets such as Hafez (d. 1398), Khayyam (d. 1313), Urfi (d. 1591), Feyzî-i

Hindî (1547–1595), and Mohtasham Kashani (d. 1588), and on occasion even claimed to surpass them.

Nef'î's Turkish and Persian *Divans*, as well as his collection of satires titled *Sihâmü'l-qezâ*, are extant. Numerous copies of his Turkish *Divan* exist around the world. In terms of quantity, qasidas occupy the largest space in the Turkish *Divan*. Besides the panegyrics written for the Prophet and for Mevlana, the *Divan* includes qasidas composed for three sultans, eight grand viziers, two şeyhülislams, and numerous influential state officials.

The Persian *Divan* consists of eight qasidas (four dedicated to Mevlana, one to Sultan Murad, one to Sultan Selim, one to Hüsam Giray Khan, and one to Şeyhülislam Mehmed Efendi), one *Saqiname*, one fahriye qit'a, twenty-one ghazals, and 171 rubaiyat. It can be noted that the poems in Nef'î's Persian *Divan* are predominantly characterized by a Sufi atmosphere.

Sihâmü'l-qezâ is the work in which Nef'î's most famous satires are collected. Due to its harsh and severe language, the work has not always received the literary recognition it deserves. Manuscript copies of this work are very rare. Based on the extant copies, researchers note that the poet primarily directed his satirical verses toward his father, Gürcü Mehmed Pasha, Kêmankeş Ali Pasha, Eknmekçi-zade Ahmed Pasha, Veysi, and Nevîzade, composing them in the forms of manzumé (verse), qasida, tarkibband, and qit'a. In addition, the work also includes satires aimed at other influential state officials and fellow poets. Among Nef'î's fellow poets targeted in his satires were Mentiqi, Fırsatı, Nigar, Nihan, Bahsî Kâmil, Qânizâde Nâdirî, Ruhî, Itrî, Riyâzî, Kafzâde Fâizî, Azmizâde Haletî, Meşrebî, and Nevîzâde Atâyî. It would not be an exaggeration to say that there was hardly any notable figure whom Nef'î did not satirize or speak against with sharp words whenever he had the opportunity. Ranging from irony and innuendo to direct insult and invective, many of these satires contain harsh expressions that have often hindered their appreciation as literary works. Nevertheless, *Sihâmü'l-qezâ* remains an excellent example of satirical poetry and lively invective. Within moral and ethical boundaries, these works provide the reader with clear demonstrations of the poet's brilliant reasoning and formidable mastery of satire. This further attests to Nef'î's remarkable success in the field of satire. As noted above, Nef'î's satires are collected in *Sihâmü'l-qezâ*. Manuscript copies of the work exist in Istanbul, Edirne, Ankara, and London [2, 130–141]. Researchers sometimes question whether *Sihâmü'l-qezâ* truly belongs to Nef'î. The main reason for this doubt is that, in terms of language and style, the satire differs completely from the poet's *Divan*. The pure, clear, and refined language and style seen in his *Divan* are replaced in *Sihâmü'l-qezâ* by very coarse expressions. Saffed Sıdkı presents his study on *Sihâmü'l-qezâ* as "the spread of the eternal and original sin of *Divan* literature" [9, 23]. Metin Aqquş notes: "The work, which also contains various satirical poems, is filled with expressions related to accusation, contempt, and invective, which overshadow its literary value" (2,103). Mehmet Fuad Köprülü observes: "Except for a few poems in which the harmony and grandeur remind one of the work of a great poet, most of the work consists of coarse, meaningless, and often obscene verses.

It is difficult to believe that a great poet like Nef'î would compose such vulgar and rudimentary poetry" [7, 395]. Turhan Tan (Samih Fethi) states: "In his qasidas, Nef'î is a fairy of harmony; in his satires, he is a drunken, foul-mouthed vagabond of the streets" (10). İsmail Habib Sevuk comments: "Many of the poems in *Sihâmü'l-qezâ*, where his satires are collected, are so full of obscenities that even a solitary reader hesitates to read them" [8, 152].

These assessments highlight the stark contrast between Nef'î's refined *Divan* style and the raw, provocative nature of his satirical compositions, which has both intrigued and troubled scholars.

Karahan states: "Apart from these delicate subtleties, the poems in *Sihâmü'l-qezâ* do not possess great literary value. Occasionally, there are passages among these poems that reflect the characteristics of Nef'î's artistry, but these are few. The manuscript copies of the work are also scarce no more than four or five—and they differ from one another" [6, 10].

In a satire by Şeyhülislam Yahya, he called Nef'î an unbeliever (kâfir), and the response Nef'î gave is known as a very famous example of satirical verse in Opoetry.

Of Şeyhülislam Yahya's poem:

Şimdi xeyli suhânverân içre,
Nefî mânendi var mı bir şair.
Sözleri sebâyî-müelleqâdır,
İmrü'l-Qeys kendidür kâfir.
("Now, among many eloquent poets,
Is there one comparable to Nef'î?
His words are like suspended ornaments,
Yet he is, like Imrü'l-Qays, an unbeliever (kâfir)."

This verse juxtaposes praise for Nef'î's poetic skill with a sharp accusation regarding his personal or religious character, reflecting the sharp and satirical tone common in *Divan* literature.)

Of Nef'î's response:

Bize kâfir demiş müftî efendi,
Tutalı ben ana diyem müslimân.
Varulduğda yarın rızâ-i cezâya,
İkimiz de çıkaruz anda yalan. [2,250]

(The Mufti Efendi has called me an unbeliever (*kâfir*),
I will consider him a Muslim in return.
When we appear before the Lord on the Day of Judgment,
Both of us will be proven false then."

This reply cleverly turns the accusation back on the accuser, employing the sharp wit and moral reasoning characteristic of Nef'î's satirical poetry.)

With this qit'a, which appears primarily in his *Divan* and in some copies of *Sihâmü'l-qezâ*, Nef'î once again demonstrated his mastery in composing satire. However, such examples are quite rare. The majority of his poems focus more on the pride of the people he criticizes, often satirizing their outward appearance. In this regard, his qasida satirizing Fırsat provoked considerable objection among critics.

Ana benzerdi ger sürse yüzine zerbeçav îblis,

Ana benzerdi ger cinnî olaydî kehru-bâ-talât. [2, 200]

(Like a mother would, even if the devil with striking eyes approached your face,

Like a mother would, even if a jinn possessed the amber-colored beauty."

The verse employs vivid metaphors and supernatural imagery to emphasize protective care and admiration, characteristic of Nef'î's skillful use of figurative language in satire and praise.)

In *Sihâmü'l-qezâ*, in a qit'a titled "Derr-ı Haqqı Mehmed Ali," we witness that the person being criticized is openly insulted:

Görmedim səncileyin rînd-i cahan-dide gidi,

Bire nazuk, bire akmaq, bire vadide gidi.

Sen de İtri gibi harlikde qalup ger şimdi,

Taib olsan nice olurdı bire varidə gidi.(2,247)

(I have never seen such a libertine with worldly perception;

One is delicate, another foolish, yet another in the valley.

If you, like Itrî, remained steadfast in your ardor

Imagine what would happen to one in the valley."

The verse combines vivid characterizations with moral and social commentary, reflecting Nef'î's sharp observational skill and his mastery in satirical expression.)

In the satire addressed to Gürcü Mehmed Pasha, titled with the redif "a köpek," Nef'î employs extremely harsh language and does not hesitate to insult the person he criticizes.

Molla Sultana zıbıkçıbaşı da olsa eğer,

Görünür bana yine cariyeden kem a köpek. [2,161]

("Even if Molla Sultan were the head of the guards,

He still appears to me as less than a dog compared to a concubine."

This couplet illustrates Nef'î's bold and provocative use of language in his satirical poetry, directly mocking the subject with vivid and scornful imagery.

Many Ottoman writers drew inspiration from the works of the prominent Azerbaijani poet Fuzuli. Ömer Nefi also composed poems under the influence of Fuzuli's works. What primarily connects Fuzuli and Nefi are the imagery and motifs in their ghazals and qasidas, as well as the great importance both poets attached to the art of language and poetry. Fuzuli, in Azerbaijani literature, served as a source of inspiration for Ottoman writers not only due to his aesthetic richness and poetic subtlety but also through the exemplary works he produced in the genres of ghazal and qasida. In Ömer Nefi's poetry, Fuzuli's influence is primarily evident in the choice of imagery and poetic motifs. The delicate metaphors, symbolic depictions, and emotional richness characteristic of Fuzuli's poetry are likewise reflected in Nefi's works.

In both ghazal and qasida genres, Nefi adopted Fuzuli's motifs and stylistic techniques, while simultaneously enriching this influence with his own poetic approach. For instance, in his ghazals, Nefi not only emulated Fuzuli's themes of love, nature, and philosophical reflection but also introduced new nuances aligned with the social and cultural context of his Ottoman milieu. This demonstrates that he did not merely replicate Fuzuli's work but successfully integrated the poetic ideas he derived from Fuzuli into his own creative expression. A key factor linking Fuzuli and Nefi is their shared approach to the qasida genre. Both poets treated this classical form with great care, emphasizing intricate stylistic devices, thematic depth, and the aesthetic refinement of language, which reflects their similar poetic sensibilities and the high value they placed on the art of poetry.

In divan literature, Ömer Nefi stands out as the poet with the largest number of qasidas. Similar to Fuzuli, who composed qasidas in three different languages, Nefi's divan also contains a substantial collection of qasidas. Like Fuzuli's, Nefi's qasidas are primarily composed of na'ts (poems in praise of the Prophet), eulogies, and fakhriyyas (poems of self-praise). This structural and thematic similarity reflects the influence of Fuzuli on Nefi, while also highlighting Nefi's ability to adapt these classical forms to his own poetic vision. Both poets demonstrate a meticulous attention to linguistic refinement, thematic organization, and aesthetic expression, which underscores their shared approach to the qasida genre within the broader context of Ottoman and Azerbaijani divan traditions.

Conclusion

Ömer Nefi can be regarded as a poet with a distinctive place in Ottoman divan literature. His work is notable not only for its formal and stylistic richness but also for successfully assimilating the influence of great Azerbaijani poets such as Fuzuli. Nefi applied Fuzuli's imagery, motifs, and poetic figures in his own works while recontextualizing them within the Ottoman cultural and literary environment. This demonstrates that he was not merely an imitator but a creative and original poet.

The great importance Nefi attached to the art of language and poetic aesthetics, the precision of his imagery, and the expressive richness of his ghazals and qasidas distinguish him from other Ottoman poets of his time. Moreover, his assimilation of Fuzuli's influence within his own style strengthened the literary connection between Ottoman and Azerbaijani traditions, creating a cultural and literary bridge between the two.

In conclusion, Ömer Nefi contributed significantly to the development of classical Ottoman divan literature while successfully integrating the poetic legacy of Azerbaijani poets into the Ottoman context. His oeuvre remains a vivid example of aesthetic richness, poetic subtlety, and the literary and cultural connections between these two traditions.

Studying the works of this great poet, particularly his satires, and introducing them to the Azerbaijani scholarly community is especially significant within the context of researching literary relations between Azerbaijan and Turkey.

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LESSING'S ART-THEORETICAL VIEWS IN HIS DRAMATIC WORKS

Muslumova O.
Ganja State University
Candidate of Philological Sciences,
Associate Professor, Senior Lecturer Azerbaijan, Ganja

ИСКУССТВОВЕДЧЕСКИЕ ВЗГЛЯДЫ ЛЕССИНГА В ЕГО ДРАМАТИЧЕСКИХ ПРОИЗВЕДЕНИЯХ

Муслимова О.С.
Гянджинский государственный университет
Кандидат филологических наук, доцент,
старший преподаватель Азербайджан, Гянджа
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Abstract

As the author observes, it was only during Lessing's lifetime, that German literature began to play an influential role in the lives of the people and the nation, and that within the course of 50 years, literature became one of the most important aspects of life, helping to overcome backwardness. Historical necessity brought forth Lessing's combative spirit and placed him in the service of his homeland. Lessing was the father of modern German literature, and he reigned supreme over it. Few people of the 18th century can rival him in genius and historical significance. The result of his work was not only the rebirth of literature, but also that of the nation. Lessing's greatness lies in the fact that he fruitfully influenced the lives of the German people. Through him, literature became a driving force of national life, for he understood the dire situation of his people. He also understood the importance of literature for life and showed it the way, making it the center of national life and creating significant works himself. In doing so, he accelerated the development of his nation. The aim was not simply to eliminate classical tragedy from literature and theater; a new theater had to be created that corresponded to the interests of the nation, especially those of the working class. Since the repertoire of German traveling theater troupes did not address social problems, but only the private life of the provincial lower middle class, Lessing took the English dramatist Shakespeare as a model. Dramas should be written according to his example. Lessing himself attempted this and included his Faust drama, of which only fragments have survived, in his theoretical treatise.

Аннотация

Как отмечает автор, лишь при жизни Лессинга немецкая литература начала играть влиятельную роль в жизни народа и нации, и за 50 лет литература стала одним из важнейших аспектов жизни, помогая преодолеть отсталость. Историческая необходимость пробудила в Лессинге боевой дух и поставила его на службу родине. Лессинг был отцом современной немецкой литературы и безраздельно правил ею. Немногие люди XVIII века могут сравниться с ним по гению и историческому значению. Результатом его работы стало не только возрождение литературы, но и нации.Величие Лессинга заключается в том, что он плодотворно повлиял на жизнь немецкого народа. Благодаря ему литература стала движущей силой национальной жизни, поскольку он понимал тяжелое положение своего народа. Он также понимал важность литературы для жизни и указывал ей путь, сделав ее центром национальной жизни и создав значимые произведения сам. Тем самым он ускорил развитие своей нации. Цель заключалась не просто в искоренении классической трагедии из литературы и театра; необходимо было создать новый театр, соответствующий интересам нации, особенно интересам рабочего класса. Поскольку репертуар немецких странствующих театральных трупп не затрагивал социальные проблемы, а лишь частную жизнь провинциального низшего среднего класса, Лессинг взял за образец английского драматурга Шекспира. Драматургии должны были писаться по его примеру. Сам Лессинг предпринял эту попытку и включил свою драму о Фаусте, от которой сохранились лишь фрагменты, в свой теоретический трактат.

Keywords: German literature, historical necessity, national life, social problems, literary revival

Ключевые слова: немецкая литература, историческая необходимость, национальной жизни, социальные проблемы, возрождение литературы

The literature of the German Enlightenment and the entire Enlightenment movement are so closely connected with the personality of Lessing that it is impossible to imagine it without him. He was its greatest defender in all areas of intellectual life, an outstanding theorist of the new democratic aesthetics and a defender of the interests of his people against princely despotism, nationalism and medieval scholasticism. Lessing was a great realist poet who gave German literature a clear historical perspective. Historical necessity awakened in Lessing the spirit of struggle and directed him to serve his homeland. Lessing was the father of modern German literature. The result of his work was the revival not only of literature, but also of the nation.

Lessing's greatness lies in the fact that he had a fruitful influence on the life of the German people.

Through him, literature became the driving force of national life, because he understood the difficult situation facing his people. He also understood and guided the importance of literature for life, making it the center of national life and creating significant works himself. In doing so, he accelerated the development of his nation.[3]

A prominent contribution to the aesthetics of the Enlightenment was Lessing's artistic and philosophical treatise "Laocône, or On the Limits of Painting and Poetry" (1766). In this work, Lessing criticized the classical art theorists Spence (England) and Cailles (France) for their claims that the poet should depict only the elegant, majestic, and noble, thereby contributing to the beautification of courtly life. Lessing also subjected the fashionable old saying that painting is silent poetry and poetry makes painting speak to a detailed and detailed critique, arguing that this condemned the poet to passive thought. Lessing's main goal was to define the difference between visual art and poetry, both in terms of content and form, to define their boundaries, and thereby to identify the specific characteristics of the two art forms.

In painting (or sculpture), the situation is different. And Lessing uses the Laocoön Group as an example to illustrate the principles of visual art. According to Lessing, the depiction of beauty was the highest artistic principle for the ancient Greeks. Laocoön doesn't scream here because screaming would have disfigured his face in a disgusting way. In portraying the passions, the ancient masters knew how to maintain the right balance. Truth and naturalness had to harmonize. Therefore, the sculptors replaced the screams with sighs. [1]

Lessing's work was also a great social achievement with a progressive impact; it included the demand that literature actively engage with life and no longer tolerate suffering. The people of the third estate, awakening to active action, did not want gladiators portrayed, but rather to proclaim their suffering to the whole world.

Lessing also points to another significant difference between literature and visual art. Virgil's Laocoön is in his priestly vestments, while the sculptors depict the group naked. Here, too, says Lessing, the law of beauty was at work. Clothes can be beautiful, but there is nothing more beautiful than the human body.

Although Lessing underestimated the possibilities of the visual arts in his "Laocoön," he nevertheless called for creative activity through the force of his logic. The work, wrote Goethe, "...tore us from the realm of meager contemplation into the free fields of thought." Through this philosophical treatise on art, Lessing had overcome prevailing aesthetic views, replaced the superficial observation of artworks with profound analysis, and provided a model for this analysis. He liberated artists, and especially poets, from the dogmas that hampered the development of art and literature and were based on arbitrary assertions. Art and literature were shown a path along which they could develop. [4]

Lessing's work was also a great social achievement with a progressive impact; it included the demand that literature actively engage with life and no longer tolerate suffering. The people of the third estate, awakening to active action, did not want gladiators portrayed, but rather to proclaim their suffering to the whole world.

The work "Hamburg Dramaturgy" illustrates the poet's struggle against the ideology and aesthetic principles of courtly classicism and demonstrates Lessing's endeavor to create a new theater capable of disseminating the ideas of the Enlightenment. Therefore, the most important issues addressed here are the refutation of classicist aesthetics, character development in drama, plot development, and the concept of the tragic. The "Hamburg Dramaturgy" comprises 104 pages; it was written during Lessing's time as a theater critic in Hamburg. It is the most comprehensive work on Enlightenment aesthetics and its significance extends far beyond the 18th century. Some of the book's ideas remain highly relevant today. At that time, there were no national dramas in Germany, and what was performed on stage was imitation or translation, primarily of French plays. However, since the French classical theatre of the 17th century did not correspond to the national interests of the German people and the spirit of the Enlightenment, it was strongly criticized and rejected by Lessing. [2]

The aesthetics of classicism contradicted the Enlightenment views on drama in every respect: in the subject matter, in the rigid rules of structure, in the development of the plot, in the shaping of the characters, and in the language. (The mythological subject matter and the dignitaries of the feudal world, as depicted in classical tragedy, were alien to the common people and did not resonate with them. Aristocratic ideology even exerted a corrosive influence on ordinary people. "The names of princes and heroes can lend a play pomp and majesty; but they contribute nothing to emotion. The misfortune of those whose circumstances are closest to our own must naturally penetrate most deeply into our souls; and when we feel pity for kings, we do so as men, not as kings.") This means that the dramatic character must resemble the ordinary person, must be like most of the people in the audience, so that everyone can say: "Yes, that's a person like me." The action on stage should move the spectator; the dramatic conflict should stir him when he sees that his cause is being championed. The poet must capture the characteristic and Design it in a way that avoids anything accidental. [5]

Historical figures should not merely be copied, but rather the era must be revealed through them. Therefore, the character must be historically accurate.

The question of realism, that is, the shaping of reality, which here is described as the imitation of nature, is one of the fundamental questions of the work. Here, Lessing refers to Shakespeare, who wrote without classical rules but always achieved his goal. He should be imitated, that is, one should learn to write as he did, to grasp life truthfully and comprehensively. One should imitate reality. "In nature, everything is connected to everything else; everything intersects, everything changes with everything else, everything transforms into one another." However, the reflection of the phenomena of social life is not yet the whole of nature. One must also consider the nature of our feelings and mental

faculties. Lessing interprets the embellishment of nature as the interest we have in this reality. Thus, he views the work of art as a representation of real life, combined with the poet's understanding of that life, which corresponds to our modern understanding as well. However, one should not imitate every reality. The idea of the artwork must emerge from the qualities and actions of the artistic figures.[2]

How does drama achieve its effect? Fear is understood as a feeling that arises in the spectator when they see the suffering character on stage. The purpose of the tragic should be understood in the spectator's participation, in their empathy. Therefore, the hero on stage must feel and think like the person in the audience. The conviction the spectator arrives at has an educational effect. Since the action appears present on stage, Lessing considers theater the best means of educating people. The interplay of cause and effect results in the unity of the action, and this alone was absolutely required by the ancients. The unity of time and place is not necessary for the dramatic work. It was only brought about by the conditions in which Greek drama was performed. Therefore, there is no point in maintaining the unity of time and place now.

The plot must have a natural cause, be reasoned, and be directed toward a goal. Events must not simply be strung together. Passions should not be described; they must arise before the eyes of the spectator, not abruptly, but steadily increasing. Lessing rejects all belief in miracles and demands a realistically grounded plot. We tolerate no miracles, Lessing argues, because the theater is meant to educate people. For him, everything must be clear. The task is not to show what is to happen, but how it is to happen. The dramatic effect lies in this process of becoming. [6]

The "Hamburg Dramaturgy" had a tremendous impact on the development of Enlightenment Theater. The dramatic art of Goethe and Schiller, who brought German drama to its classical heights, was based on it. However, Lessing's dramaturgical theory also reveals its limitations.

In his dramas, Lessing addressed the fundamental problems of the time: in "Minna von Barnhelm," the question of national unity; in "Emilia Galotti," the conflicts between tyrannical princes and their subjects; and in "Nathan the Wise," religious agitation and national hatred. These dramas were also a practical realization of Lessing's theories on art.

The comedy "Minna von Barnhelm" (1767) takes place in a Berlin inn shortly after the Seven Years' War. Major von Tellheim, a Prussian officer, performed a noble deed during the war. He was tasked with collecting war contributions from a district of Saxony. However, since the population could not raise the required sum, Tellheim paid the money out of his own pocket and had a bill of exchange drawn for him, which was to be redeemed after the war. This act won him, the Prussian officer, the love of the Saxon lady Minna von Barnhelm, and he became engaged to her. After the war ended, he was discharged from the army and accused of having accepted bribes from the Saxons. Now he is so poor that he cannot even pay his bill at the inn. In his desperation, he believes he has no right to bind his beloved to her promise. But the brave and clever Minna outsmarts his pride and wins him over. [4]

With this play, Lessing put his artistic views on comedy into practice and proved that comedy can address major social issues without compromising the comic-satirical nature of the genre, and that, like drama, it must accurately reflect historical truth, the customs, and the traditions of the people. The servants here are as clever as their masters, indeed, even wittier.

The work is a truly realistic national comedy because it faithfully depicts the conditions of the time. The masterful dramatic structure and the playfully serious interplay of the plot are also realistic. The characters are real people of flesh and blood, taken directly from life and imbued with the poet's democratic ideals. This is evident in their actions, their way of thinking, and their language. The poet is particularly successful with the female characters. Minna is a new type of woman in German literature: dignified, uninhibited, and charming. The servants Just and Franzisca act freely and as equals to their masters. Their language is simple and clear, using colloquial words and phrases, which are mostly attributed to Just. It differs significantly from the German-French mixture spoken by Frederick II's courtiers. [3]

Besides its political significance, "Emilia Galotti" also held great artistic importance. Since it was dangerous to openly expose tyranny under the ruthless, arbitrary rule of the German petty states, the poet resorted to a disguise. He took a well-known Roman story in which a father kills his daughter Virginia to save her from the persecutions and atrocities of a tyrannical debaucher. This led to a popular uprising and the tyrant's overthrow. To make the drama relevant to his time, Lessing gave the heroes Italian names, but depicted the conditions in Germany during that era. The poet understood that his work would not provoke an uprising because social conditions were not yet ripe for it, but it was intended to rouse people from their indifference or, as he put it, to stir them up. And indeed, it had a rebellious effect for more than a century. Franz Mehring wrote that the revolutionary character is what has kept the play so fresh. It was a passionate indictment of the entire feudal order, but especially of the tyrannical rule of the German dynasties. The work illustrates typical abuses of 18th-century German life. There was no force in the country capable of breaking the tyranny, but the protests grew. The artistic theories presented in his "Hamburg Dramaturgy" came to life here, becoming reality. Lessing had created a great national drama that became a model for German literature. The same characters appeared here as existed in life. The purely personal fate was replaced by the social conflict between rulers and the oppressed; social protest appeared on stage. According to their way of life and social position, the positive characters in the drama belong to the Third Estate. They are the oppressed and the innocently suffering. Social injustice had to be most starkly revealed in the character whose soul was still pure. Emilia is such a character. Her father wanted to protect her from the vices of court life and therefore disapproved of her mother's desire to spend the winter with her daughter in the city. Raised strictly under the care of her parents,

she is too weak for the machinations of feudal tyranny and dies early. [6]

In form, Lessing's last dramatic work, "Nathan the Wise," is more of a philosophical poem than a drama. The Enlightenment thinkers, especially the French, used dramatized polemical writings to directly express their combative spirit.

Lessing, who despised national hatred and religious conflict, condemns these artificial barriers in his work as unnatural and unavoidable. Nathan rises above these prejudices and is called the Wise Man because of his wisdom. Although his entire family was murdered during a persecution of Jews, he took in a Christian child and raised him with love for all people. This true humanism leads people away from religious disputes to the realization that a person's worth is not determined by their religion or nation.

Although the drama's plot is closely connected to the main character, the characters have individual traits and are shown in their development, with the exception of the Patriarch. He stands isolated and unchanging. Against all reason, he persists in his plan to corrupt Nathan because he is a Jew.

In matters of religion, the work comes close to an atheistic worldview, since ultimately each of the three religious confessions is rejected as misanthropic and a dogma-free humanism is advocated as the basis of human society. With this play, Lessing put his artistic views on comedy into practice and proved that comedy can address major social issues without compromising the comic-satirical nature of the genre, and that, like drama, it must accurately reflect historical truth, the customs, and the traditions of the people. The servants here are as clever as their masters, indeed, even wittier. [5]

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PHYSICAL SCIENCES

APPRAISAL OF CONCEPT AND BETTER UNDERSTANDING OF THEORY OF EVERYTHING OR GOD EQUATION AND CONSEQUENCE OF UNIVERSE

Dr Hossain K.
Vice Chancellor, Bangladesh Maritime University
Dhaka, Bangladesh
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Abstract

The Theory of Everything (ToE), also known as God Equation, is physics' quest to unite general relativity or gravity and quantum mechanics or other forces into one framework, describing all forces and particles, with String Theory as a leading applicant. The development of ToE or God Equation is to unify the four fundamental forces (as gravity, electromagnetism, strong and weak nuclear forces) into a single, sophisticated equation, satisfying Einstein's dream. But the problem is general relativity (or smooth spacetime) clashes with quantum mechanics (or discrete particles). String Theory posits fundamental vibrations of one-dimensional strings, potentially unifying everything. It describes how these strings propagate through space and interact with each other. A successful ToE would explain fundamental constants, black holes, the Big Bang, and potentially time travel. The future of the universe, or the most accepted scenario where the universe expands forever, cooling until stars die out and no new energy can be generated, making life impossible (known as Big Freeze or Heat Death). A scenario where dark energy accelerates expansion so violently it tears apart galaxies, stars, planets, and even atoms (known as Big Rip). Another a cyclic model where the universe expands and contracts, potentially leading to a new Big Bang (known as Big Bounce). The ToE is explaining the universe's fundamental rules, would provide the ultimate physical basis for predicting its beginning (as describe in Big Bang) and its end (as explain in Big Freeze/Big Rip/Big Bounce). A successful ToE would explain the universe's ultimate origins and ultimate fate, potentially revealing how our universe emerged from quantum fluctuations. However, uncertainty and mystery remain as the secret story of the universe. This is a review article to appraise the concept of Theory of Everything or God Equation and explain the consequence of universe on the basis of existing theory and latest scientific development.

Keywords: NASA, Dark matter, galaxies, good equation, ToE, LHC

1. Introduction

There is simple explanation of the well-known theories about Bangs, black holes, dark matter, parallel cosmoses, antiparticles and teleportation's of man into the past. The universe is made up of countless galaxies. They arise and disappear in the same way, and differ in size and activity, which also depends on the age of the galaxy. The universe is completely filled with dark matter particles, except for the places where galaxies are designed and formed from these same particles. The basis of the galaxy is the nucleus. The core of the galaxy with its mass and proportional attractive force absorbs all dark matter particles, which in their flight towards the core cause gravity on all material objects. The size of the gravitational field depends on the mass of the nucleus. Since the nucleus is constantly losing mass, as Hawking resolved, its field is also constantly decreasing. For this space, Albert Einstein claimed that it is a 'curved space-time' into which, due to the curvature towards the core, all material objects fall and that this is gravity. Einstein's 'General Theory of Relativity' proposed that gravity isn't a force but a manifestation of the curvature of spacetime (as a unified concept combining the three dimensions of space and the single dimension of time) caused by mass and energy, meaning massive objects warp spacetime, and other objects follow these curves, explaining planetary orbits and light bending. So, heavy objects like stars and planets create dips or curves in this spacetime fabric, much like a bowling ball on a stretched rubber sheet. The thinking of scientist before was wrong.

The gravitational field is an ordinary space in the form of a real sphere that surrounds the nucleus. And logical human reason does not understand how space, and especially time, can be twisted. From this metafiction later developed the ridiculous theory of Warp Drive, in the sense of warping subspace and making a shortcut to distant space bodies. Always from a wrong theory, especially if the author is known and recognized, irresponsible theories are developed that do not help the development of the evolution of human civilization. On the contrary, when the core of a galaxy forms and explodes from itself a hydrogen star, then that star with its core marks its own gravitational field, within the gravitational field of the galaxy. From this field, all dark matter particles are absorbed into the core of the star. Particles outside this field continue to flow towards the galactic core. When a star forms its own star and later a planet, the same scenario occurs. Dark matter particles are absorbed from the Earth's gravitational field towards the Earth's core, while the remaining ones continue to flow towards the Sun's core. In this way, the 'Interpolation of gravity fields in space' was performed. Based on this knowledge, it becomes a logical explanation for the pioneer anomalies and the Moon that rotates like the Earth, contempt the fact that according to Zero Point calculations, the Moon should rotate around the Sun, because the Sun's gravity is stronger than the Earth's at the position of our satellite.

On the other side of the coin, there are about two thousand billion galaxies in the universe, if we divide them among every person on earth, then every child,

old man and young man will have 250 galaxies. In which there are not billions but trillions of stars. Thus, there is no shortage of stars and planets in the universe, but there are also some places in the universe where there is nothing, that is, there is no name or sign of stars and planets there. This is very strange, isn't it? There are stars and planets everywhere in the universe. But this area is completely uninhabited, it is dark here. National Aeronautics and Space Administration (NASA) scientists saw a mysterious area about 700 million light years away in 1981, which was very strange. Because this strange and empty area was completely empty in the middle of the universe decorated with galaxies. This strange area is called Boötes void in the language of scientists. This area is completely empty, so there is intense darkness in this "area" because there is no solid body for the reflection of light. The universe is in a severe state of load shedding in this area. NASA scientists believe that the speed at which the universe is expanding. And the way it is expanding in every direction, there should be thousands of galaxies in this place, but there is nothing far away. Why has the matter of the universe not reached this area? This is a mystery. This seemingly empty area is so vast. Interestingly, if we leave fifty thousand space vehicles in the 'Boötes void' area without sensors, they will cover a distance of trillions of years. And more interestingly, they will not collide with anything in this area, because there is nothing in this area.

There are no elementary particles like electrons or quarks in string theory, rather pieces of vibrating strings. Each vibration mode corresponds to a different particle and determines its charge and its mass. In the current understanding of the theory, those strings are not "made of" anything: they are the fundamental constituent of matter. The consequences of replacing point-like particles by vibrating microscopic strings are enormous. The only consistent framework to describe those strings implies a 10 or even conceivably an 11-dimension world in which 6 or 7 dimensions are curled up. Those extra dimensions are the ones which determine the properties on the earth we live in. The larger dimensions are which we distinguish as the ordinary space and time. On the other hand, in superstring theory's 10-dimensional spacetime, we still see only a 4-dimensional spacetime. Besides, we need to link those two if superstrings are to describe our universe. To achieve this, we curl up the extra 6 dimensions into a small dense space. If the size of the dense space is of order the string scale (10^{-33} cm) we would not be able to perceive the presence of these extra dimensions directly and they are just too small. Ultimately, the end result is that we get back to our familiar (3+1 or 4)-dimensional world. But there is a tiny 'ball' of 6-dimensional space associated with every point in our 4-dimensional universe.

String theory considers as unified theory, and it takes efforts to explain all four forces experience in nature. Now, one of the solutions of the string equations is a force that founds like gravity. It is evidence to the power and the positive side of string theory and which physicists would rather give up the very notion of space and time as well as admit a 10-dimension world. Rather than question the path on which the quest for a unified theory has led them. String theory could successfully account for gravity and forecast super-symmetric particles. But until a few years ago it had little connection with puzzles in physics. There were no results or concrete predictions to show off. It could have been nothing more than a beautiful mathematical construction. But in 1996 situation has changed. Andrew Strominger, at the Institute for Theoretical Physics in Santa Barbara, and Cumrun Vafa from Harvard University, used string theory to construct a certain type of black hole. Which was similar way one can construct a hydrogen atom by jot down the equations, as derived from QM, which define an electron bound to a proton. Other approaches to quantum gravity like LQG exist, but string theory is the most popular candidate for a complete ToE.

In the late 1970's Strominger and Vafa established a result derived by Jacob Bekenstein and Stephen Hawking. Bekenstein and Hawking found that the amount of entropy in a special kind of black hole was very large. This was a astonishing result, as no one could understand and nor did the calculations give any insight. Question remains as how an object as simple as a black hole could have such a large amount of entropy or disorder within it. So, to building such special black hole using string theory, Strominger and Vafa were able to obtain the correct value for the disorder predicted by Bekenstein and Hawking. This result excited the physics community. It was the first time; a result derived with classical physics could be obtained from string theory. Even though the black holes for which the result was derived have very little in common with the black holes which are believed to sit in the middle of galaxies. This new computation illustrated the linking between strings and gravity. In addition, the computation provides insight into the physical reasons for the answer. No one knows yet if string theory is the ultimate theory or the ToE, if there is such a thing. But the theory's incredible sophistication and potential make it a strong front-runner to further explain the inner workings of the universe well into the next century. Edward Witten is an American theoretical physicist known for his contributions to string theory, topological quantum field theory, and as a pioneer or one of its leaders said, 'String theory is a part of twenty-first century physics that fell by chance into the twentieth century.'

With Webb, the science team can now see where stars formed and how they are distributed, in a similar way to how the Hubble Space Telescope is used to study local galaxies. Webb's view provides a unique opportunity to study star formation and the inner workings of infant galaxies at such an unprecedented distance. An international team of astronomers have used the NASA/ESA/CSA James Webb Space Telescope to discover gravitationally bound star clusters when the Universe was 460 million years old. This is the first discovery of star clusters in an infant galaxy less than 500 million years after the Big Bang. In the early Universe, young galaxies underwent momentous burst phases of star formation, and generating substantial amounts of ionizing radiation. However, because of their cosmological distances, direct studies of their stellar content have proven challenging. An international team of astronomers by using Webb, have now detected five young massive star clusters in the Cosmic Gems arc

(SPT0615-JD1), and a strongly-lensed galaxy emitting light when the universe was roughly 460 million years old, looking back across 97% of cosmic time. The Cosmic Gems arc was initially discovered in NASA/ESA by using Hubble Space Telescope images obtained by the RELICS (Reionization Lensing Cluster Survey) programmed of the lensing galaxy cluster SPT-CL J0615−5746. The science team can now see where stars formed and how they are distributed with Webb, in a similar way to how the Hubble Space Telescope is used to study local galaxies. Today Webb's view provides a unique opportunity to study star formation and the inner workings of infant galaxies at such an unprecedented distance. Now, James Webb Space Telescope (JWST) offers a supreme view into early galaxies, allowing scientists see star birth and galaxy evolution in the distant, infant universe like never before. Due to its infrared vision and gravitational lensing, we can see-through details about star clusters, dust, and gas in galaxies just moments after the Big Bang, like the Cosmic Gems arc.

String theory is among the most well-known concepts in modern physics, but it's also one of the most perplexing. The central idea is that the elementary particles we notice are not point-like dots, but instead tiny strings so small that even our best instruments cannot tell them apart. This also anticipates that there are additional dimensions to space in addition to the obvious length, breadth, and depth, but we do not perceive them because they are clustered in small spaces. Although these ideas are bizarre, the main issue for string theorists has been the difficulty in testing them. String theory is a broad and diverse subject that attempts to answer a number of fundamental physics questions. It has made noteworthy contributions to mathematical physics, which have been applied to a wide range of issues in black hole physics, early universe cosmology, nuclear physics, and condensed matter physics, including stimulating a number of major advances in pure mathematics. String theory is a candidate for such a theory of everything, a self-contained mathematical model that encompasses all fundamental forces and forms of matter, because it has the possibility to provide a inclusive description of gravity and particle physics. Einstein has tried to seek a unified field theory, a solitary model to explain the universe's fundamental interactions or mechanics. Today's search is for a quantized unified field theory which also explains the structure of matter. This is known as the search for an all-encompassing theory. String theory transferred into superstring theory, with its six higher dimensions in addition to its four common dimensions, is the most prominent contender as a ToE. In this investigative review article author will take an effort to appraise the concept of ToE or God Equation for better understanding to explain the consequence of universe with ultimate fate on the basis of existing theory of physics and the latest scientific development.

2. Literature Review and History Related to String Theory Explain by M Kaku

String theory is a leading candidate for a Theory of Everything (ToE), a hypothetical single framework that unifies all fundamental forces (like gravity, electromagnetism, strong and weak nuclear forces) and matter, bridging the gap between General Relativity (gravity) and Quantum Mechanics (other forces). While a ToE aims to be the ultimate unified theory, String Theory proposes how this unification might work by replacing point-like particles with tiny, vibrating strings, where different vibrations create different particles and forces, including gravity. The ToE is the ultimate goal (a complete, unified description of everything), and String Theory is a prominent, well-developed method or candidate for achieving that goal. String theory naturally incorporates gravity (via gravitons, which are closed strings) and quantum mechanics, solving a major conflict in physics. Instead of point particles, string theory suggests everything is made of one-dimensional vibrating "strings" in extra dimensions. Different vibration patterns of these strings correspond to different particles (electrons, quarks, etc.) and forces, offering a single description. String theory (and its extension, M-theory) is the most mathematically consistent framework developed so far for a ToE, but it remains theoretical, requiring extra dimensions and lacking direct experimental proof.

About the idea of Thomas H. Huxley, Kaku also said, "As the great biologist Thomas H. Huxley said in 1863, "The question of all questions for humanity, the problem which lies behind all others and is more interesting than any of them, is that of the determination of man's place in Nature and his relation to the Cosmos." On the other hand, about the idea of Planck, Kaku also said, "But Planck would always reassure Einstein. He would write, "A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because the opponents eventually die and a new generation grows up that is familiar with it." Kaku explain a situation/example by saying, "Schrödinger's Cat Schrödinger devised a simple thought experiment that exposed the essence of the problem. Place a cat in a sealed box. Put a piece of uranium in the box. When the uranium fires a subatomic particle, it triggers a Geiger counter that sets off a gun that fires a bullet at the cat. The question is: Is the cat dead or alive? Since the firing of a uranium atom is a purely quantum event, it means that you have to describe the cat in terms of quantum mechanics. To Heisenberg, before you open the box, the cat exists as a mixture of different quantum states—that is, the cat is the sum of two waves. One wave describes a dead cat. The other wave describes a live cat. The cat is neither dead nor alive but a mixture of both. The only way to tell if the cat is dead or alive is to open the box and make an observation; then the wave function collapses into a dead or live cat. In other words, observation (which requires consciousness) determines existence."

About another example Kaku saying, "To Einstein, this insight was monumental. Either Newton or Maxwell was correct. The other had to be wrong. But how could it be that you could never catch up to light? At the patent office, he had plenty of time to ponder this question. One day, in the spring of 1905, it struck him while riding the train in Bern. "A storm broke loose in my mind," he would recall. His brilliant insight was that since the speed of light is measured by clocks and metersticks, and since the speed of light is constant no matter how fast you move, space and time must be distorted in order to keep the speed of light constant!

It meant that if you are on fast-moving spaceship, then clocks inside the ship beat slower than clocks on the Earth. Time slows down the faster you move--this phenomenon is described by Einstein's special relativity." Abou Einstein Kaku said, "In one letter, he wrote despondently, "I am nothing but a burden to my relatives. It would surely be better if I did not live at all." He finally managed to get a job as a clerk, third class, at the patent office in Bern. It was humiliating but actually a blessing in disguise. In quiet of the patent office Einstein could return to the old question that had haunted him since he was a child. From there, he would launch a revolution that physics and the world upside down."

Kaku take us to ancient time by saying, "With the introduction of radio, we now had a superfast. convenient, and wireless way of communicating over long distances. Historically, the lack of a fast and reliable communication system was one of the great obstacles to the march of history. (In 490 BCE, after the Battle of Marathon between the Greeks and the Persians, a poor runner was ordered to spread the news of the Greek victory as fast as he could. Bravely, he ran 26 miles to Athens after previously running 147 miles to Sparta, and then, according to legend, dropped dead of sheer exhaustion. His heroism, in the age before telecommunication, is now celebrated in the modern marathon.) However, in present time, we take for granted that we can send messages and information effortlessly across the globe, utilizing the fact that energy can be transformed in many ways. For example, when speaking on a cell phone, the energy of the sound of your voice converts to mechanical energy in a vibrating diaphragm. The diaphragm is attached to a magnet that relies on the interchangeability of electricity and magnetism to create an electrical impulse, the kind that can be transported and read by a computer. This electrical impulse is then translated into electromagnetic waves that are picked up by a nearby microwave tower. There, the message is amplified and sent across the globe.

But Maxwell's equations not only gave us nearly instantaneous communication via radio, cell phone, and fiber-optic cables, they also opened up the entire electromagnetic spectrum, of which visible light and radio were just two members. In the 166os, Newton had shown that white light, when sent through a prism, can be broken up into the colors of the rainbow. In 1800, William Herschel had asked himself a simple question: What lies beyond the colors of the rainbow, which extend from red to violet? He took a prism, which created a rainbow in his lab, and placed a thermometer below the color red, where there was no color at all. Much to his surprise, the temperature of this blank area began to rise. In other words, there was a "color" below red that was invisible to the naked eye but contained energy. Which was known as infrared light. However, today, we realize that there is an entire spectrum of electromagnetic radiation, most of which is invisible, and each has a distinct wavelength. The wavelength of radio and TV, for example, is longer than that of visible light. The wavelength of the colors of the rainbow, in turn, is longer than that of ultraviolet and X-rays. This also meant that the reality we see all around us is only the tiniest sliver of the complete EM spectrum, the smallest approximation of a much larger universe" Kaku added, "So in the same way that Kepler and Galileo laid the foundation for Newtonian physics, Faraday paved the way for Maxwell's equations."

About great physicist Isaac Newton Kaku said, 'Isaac Newton is perhaps the greatest scientist who ever lived. In a world obsessed with witchcraft and sorcery, he dared to write down the universal laws of the heavens and apply a new mathematics he invented to study forces, called the calculus.' The American theoretical physicist and Nobel laureate in physics Steven Weinberg has written, 'It is with Isaac Newton that the modern dream of a final theory really begins. In its time, it was considered to be the theory of everything-that is, the theory that described all motion.' The story of Newton was fascination. When he was twenty-three years old and student of Cambridge University. Due to the black plague his university was closed. In 1666, one afternoon he was walking around his country estate, and he saw an apple fall from tree. Suddenly, he asked himself a question that would alter the course of human history. If an apple falls, then does the moon also fall? Before Newton, the church taught that there were two kinds of laws. The first were the laws found on Earth, which were corrupted by the sin of mortals. The second were the pure, perfect, and harmonious laws of the heavens. The essence of Newton's idea was to propose a unified theory that encompassed the heavens and the Earth. Kaku give an example from idea of Newton as "If a cannonball is fired from a mountaintop, it goes a certain distance before hitting the ground. But if you fire the cannonball at increasing velocities, it travels farther and farther before coming back to Earth, until it eventually completely circles the Earth and returns to the mountaintop. He concluded that the natural law that governs apples and cannonballs, gravity, also grips the moon in its orbit around the Earth. Terrestrial and heavenly physics were the same."

Kaku said about Johannes Kepler as, "Johannes Kepler, who was one of the first to apply mathematics to the motion of the planets, was an imperial adviser to Emperor Rudolf Il and perhaps escaped persecution by piously including religious elements in his scientific work. The former monk Giordano Bruno was not so lucky. In 1600, he was tried and sentenced to death for heresy. He was gagged, paraded naked in the streets of Rome, and finally burned at the stake. His chief crime? Declaring that life may exist on planets circling other stars. He wrote about Galilleo as, the great Galileo, the father of experimental science, almost met the same fate. But unlike Bruno, Galileo recanted his theories on pain of death. Nonetheless, he left a lasting legacy with his telescope, perhaps the most revolutionary and seditious invention in all of science. With a telescope, you could see with your own eyes that the moon was pockmarked with craters; that Venus had phases consistent with its orbiting the sun; that Jupiter had moons, all of which were heretical ideas. Sadly, he was placed under house arrest, isolated from visitors, and eventually went blind. (It was said because he once looked directly at the sun with his telescope.) Galileo died a broken man. But the very year that he died, a baby was born in England who would grow up to complete Galileo's and Kepler's unfinished theories, giving us a unified theory of the heavens." He also said, "Johannes Kepler, who

was one of the first to apply mathematics to the motion of the planets, was an imperial adviser to Emperor Rudolf Il and perhaps escaped persecution by piously including religious elements in his scientific work. The former monk Giordano Bruno was not so lucky. In 1600, he was tried and sentenced to death for heresy. He was gagged, paraded naked in the streets of Rome, and finally burned at the stake. His chief crime? Declaring that life may exist on planets circling other stars."

Again, Johannes Kepler has applied mathematics to the motion of the planets. He was a majestic adviser to Emperor Rudolf Il and possibly escaped persecution by piously including religious elements in his scientific work. Pythagoras had the insight to apply a mathematical description to worldly phenomena like music. According to legend, he noticed similarities between the sound of plucking a lyre string and the resonances made by hammering a metal bar. Kaku relate mathematics with physics by the word of Pythagoras as "Pythagoras had the insight to apply a mathematical description to worldly phenomena like music. According to legend, he noticed similarities between the sound of plucking a lyre string and the resonances made by hammering a metal bar. He found that they created musical frequencies that vibrated with certain ratios. So, something as aesthetically pleasing as music has its origin in the mathematics of resonances. This, he thought, might show that the diversity of the objects we see around us must obey these same mathematical rules." So at least two great theories of our world emerged from ancient Greece: 'the idea that everything consists of invisible, indestructible atoms and that the diversity of nature can be described by the mathematics of vibrations.' Kaku said, 'Democritus believed that 'everything could be reduced to tiny, invisible, indestructible particles he called atoms which meaning invisible in Greek. The critics, however, pointed out that direct evidence for atoms was impossible to acquire because they were too small to be observed. But Democritus could point out compelling, indirect evidence.' Kaku claimed as 'when Erwin Schrödinger, Werner Heisenberg, and others unlocked the secrets of the quantum theory, they gave us the high-tech revolution of today, with supercomputers, lasers, the internet, and all of the fabulous gadgets in our living rooms.'

String theory has also created a tremendous amount of interest, as well as a backlash. Actually, there is no the proof, in the same way that Newton did not have the proof of his inverse square law back in 1666. Sometimes, the mathematics and the ideas are ahead of the concrete experimental data. Here the Large Hadron Collider (LHC) comes into play. The Standard Model is the theory of almost everything. It works spectacularly well but it's one of the ugliest theories proposed so far. In string theory, the Standard Model just pops right out. With just a few assumptions we may get the entire Standard Model. So, the point here is that we need experimental proof and the LHC may give us hints of a deviation in the Standard Model . The LHC's goal is to allow physicists to test the predictions of different theories of particle physics, including measuring the properties of the Higgs boson, searching for the large family of new particles predicted by supersymmetric theories, and studying other unresolved questions in particle physics. The LHC is the world's largest and highest-energy particle accelerator. It was built by the European Organization for Nuclear Research (CERN) from 1998 to 2008, in collaboration with over 10,000 scientists, and hundreds of universities and laboratories across more than 100 countries. LHC is the world's largest and most powerful particle accelerator, designed to smash protons together at nearly the speed of light to study the fundamental particles and forces that govern our universe. It is the primary tool used by physicists to test the predictions of the Standard Model of particle physics.

The Standard Model is often referred to as the theory of 'almost everything' because while highly successful, it does not incorporate gravity, nor does it explain phenomena like dark matter and dark energy. Experiments at the CERN, where the LHC is located, have been instrumental in confirming the Standard Model's existence, most notably through the 2012 discovery of the Higgs boson. The discovery of the Higgs boson at the LHC was announced in 2012. Between 2013 and 2015, the LHC was shut down and upgraded. At the end of 2018, it was shut down for maintenance and further upgrades, and reopened over three years later in April 2022. This discovery was crucial because the Higgs boson is the physical manifestation of the field that gives mass to other particles, a central component of the Standard Model's framework. By continuing to operate and gather data, the LHC helps scientists explore potential new physics that lies beyond the Standard Model, seeking answers to some of the biggest remaining mysteries in physics. Scientists turned the LHC back on after a three-year shutdown. The Large Hadron Collider is the world's largest particle accelerator. Physicists and people interested in becoming superheroes alike are electrified by the possibilities. Now, the particle accelerator needed upgrades, which the pandemic extended. If all goes well, the Large Hadron Collider will run through the end of 2025. Just getting everything booted up will take about three months. After that, scientists will continue their search for dark matter, neutrinos-Opens in a new tab, and other mysteries of particle physics-Opens in a new tab.

A theory of everything is what remains after they shuck the outer layers as a framework to describe all the objects and forces within the universe's core. The theory would not mean all that much to us on the larger, outer layers of the universe, the ones that make us cry. The theory would mean everything to the primordial bulb, the seedling from which the universe grew. A theory of everything should not only reveal the divine cultivation, it should also codify the physical laws that arise from the basic forces. Even now, these forces and those laws dictate how matter moves throughout the universe. They can, for example, explain the thrusts of inanimate objects, even though what impels animate matter and how it becomes animate they do not say. The enactment of these laws, most physicists believe, afforded God a lengthy sabbatical. Natural laws reign supreme, managing the tasks that worshippers once foisted upon God. The laws keep the planets rotating, the sun burning, the people moving. Only at the moment of creation, as Stephen Hawking wrote, might God have wielded her powers, when 'all the laws would

have broken down, so God would still have complete freedom to choose what happened and how the universe began.' Afterwards, God was as superfluous to the universe as an architect is to a building once built. Stephen Hawking was unsatisfied even with ceding God the task of drafting a universe and embellishing space and time with laws. He preferred to imagine a design that was 'completely self-contained, with no singularities or boundaries.' And that was 'completely described by a unified theory.' He wanted, in other words, to unite the four known forces into one prime mover, so the universe could create itself.

Stephen Hawking believed only one set of laws could be consistent with the theory of everything. There was thus no choice when designing a universe, because only one universe was possible. He thought, God was neither a creator nor a designer. The universe was enough. To wonder what happened before the Big Bang. Hawking famously said, was as ridiculous as asking what lay north of the north pole. Hawking long insisted on the proximity of the final theory. In every insistence, he was right. Every second of every day, physicists are, repetitiously, nearer the moment when they will ascertain the final theory; should it exist. It is, however, impossible to know that such a theory exists until physicists reveal it. And it is impossible to know that they can reveal it until they do. The obtusity of modern physics hardly bodes well for anyone understanding the theory of everything, should it even exist. But this is just one problem with the idea of scientific progress; even if it is asymptotic, we never reach its limit. Hawking made a bolder claim, much as Einstein did, about the theory of everything. He insisted that everyone be able to understand the theory and argue its meaning once physicists discovered it. The universe and its math, ultimately, had to be simple enough for dullards. In fact, that was one of the primary reasons for writing books about physics and to inform the masses about the universe and prepare them for the theory of everything.

Mathematics is the mother tongue of physics. Every book about the subject is a translation, not only from another language but a different culture. Popular physics thus suffers from the same predicaments of transliteration and interpretation that all foreign works do as does the Bible. But such limitations have never stopped devotees from claims of inerrancy. Guido Tonelli is an Italian particle physicist who played a key role in the discovery of the Higgs boson, the so-called God particle, which earned François Englert and Peter Higgs the 2013 Nobel Prize in Physics. Guido Tonelli wrote his book, 'Genesis: The Story of How Everything Began, to inform il popolo about the universe.' That was not, however, the original impetus. As Tonelli explained, in a preface that appeared in the original Italian, one summer afternoon he was having lunch at a restaurant near the headquarters of Ferrari, and chatting with his hosts about 'Formula One' and electric cars. He received a phone call from Sergio Marchionne, the director of Ferrari, who inviting him to stop by Marchionne's office for a chat. Tonelli is a commander of the 'Order of Merit of the Italian Republic', owing to his leadership on one of the two teams of thousands of people that discovered the Higgs particle, yet he expected a perfunctory introduction to a harried businessman. Instead, Marchionne welcomed him to sit and asked, 'Professor, do you believe in God?' Tonelli spoke about the Big Bang while Marchionne smoked and asked so many giddy questions that Tonelli nearly missed his flight. A few months later, Marchionne invited Tonelli to the annual dinner for Ferrari executives. They spent the evening talking about black holes and Steven Hawking. Before dessert, Marchionne hushed his subordinates and asked Tonelli to speak.

Tonelli extemporized on the full life of the universe, from its birth to the discovery of the Higgs. He told, God is a fascinating question, but I doubt that God is an answer. When we answer our juvenile questions with God, we eliminate the other, harder solutions. The ones that are more humane. When I quit studying physics in graduate school, when I gave up on a theory of everything to become a writer, I coined an aphorism to comfort myself. Tonelli said, 'It is impossible to know all the answers because the question of what to do with them will always remain.' He also added, 'The universe is enough for some people. Religion is enough for others. For the rest of us, there is humanity. It, too, is enough. We all search for meaning. Some of us ordain this God. But no matter our beliefs, we must take comfort in each other, in the now, while we live and breathe, freely and unmasked, for however long we have. Since writing my first term paper in college, I had not pondered God and physics much, if at all.' Marchionne said, 'After I finished writing this essay, I reached out to the professor who had once encouraged me to write about those subjects. I planned to let her know that I did not yet know enough physics to write about God, but I was still learning about the world as I wrote.' Hawking viewed the universe as governed by natural laws, not divine intent, and saw consciousness as a product of the brain's physical processes, thus no afterlife. Hawking found meaning in life's finite nature, urging a focus on curiosity and discovery. We need to utilize the concept of Theory of Everything or God Equation to understand and explain the consequence and final fate of universe, principally based on existing theories and propositions of physics along with the latest scientific concept.

3. String Theory

Every decade or so, a stunning breakthrough in string theory sends shock waves racing through the theoretical physics community, generating a feverish outpouring of papers and activity. John Schwarz of Caltech has been speaking to conferences around the world proclaiming the 'second superstring revolution.' Edward Witten of the Institute for Advanced Study in Princeton gave a spell-binding 3-hour lecture describing it. The after-shocks of the breakthrough are even shaking other disciplines, like mathematics. The director of the Institute, mathematician Phillip Griffiths, says, the excitement I sense in the people in the field and the spin-offs into my own field of mathematics have really been quite extraordinary. Cumrun Vafa at Harvard has said, 'I may be biased on this one, but I think it is perhaps the most important development not only in string theory, but also in theoretical physics at least in the past two decades.' What is triggering all this excitement is the discovery of something called M-

theory, a theory which may explain the origin of strings. In one dazzling stroke, this new M-theory has solved a series of long-standing puzzling mysteries about string theory which have dogged it from the beginning, leaving many theoretical physicists gasping for breath. M-theory, moreover, may even force string theory to change its name. Although many features of M-theory are still unknown, it does not seem to be a theory purely of strings. Michael Duff of Texas A & M is already giving speeches with the title 'The theory formerly known as strings!' String theorists are careful to point out that this does not prove the final correctness of the theory. But it marks a most significant breakthrough that is already reshaping the entire field.

Einstein once said, 'Nature shows us only the tail of the lion. But I do not doubt that the lion belongs to it even though he cannot at once reveal himself because of his enormous size.' Einstein spent the last 30 years of his life searching for the tail that would lead him to the lion, the fabled unified field theory or the 'theory of everything,' which would unite all the forces of the universe into a single equation. The four forces as gravity, electromagnetism, and the strong and weak nuclear forces would be unified by an equation perhaps one inch long. Capturing the lion would be the greatest scientific achievement in all of physics, the crowning achievement of 2,000 years of scientific investigation, ever since the Greeks first asked themselves what the world was made of. But although Einstein was the first one to set off on this noble hunt and track the footprints left by the lion, he ultimately lost the trail and wandered off into the wilderness. Other giants of 20th century physics, like Werner Heisenberg and Wolfgang Pauli, also joined in the hunt. But all the easy ideas were tried and shown to be wrong. When Niels Bohr once heard a lecture by Pauli explaining his version of the unified field theory, Bohr stood up and said, 'we in the back are all agreed that your theory is crazy. But what divides us is whether your theory is crazy enough!' The trail leading to the unified field theory, in fact, is littered with the wreckage of failed expeditions and dreams.

Presently, however, physicists are following a different trail which might be 'crazy enough' to lead to the lion. This new trail leads to superstring theory, which is the best (and in fact only) candidate for a theory of everything. Unlike its rivals, it has survived every blistering mathematical challenge ever hurled at it. Not surprisingly, the theory is a radical, 'crazy' departure from the past, being based on tiny strings vibrating in 10-dimensional space-time. Moreover, the theory easily swallows up Einstein's theory of gravity. Witten has said, 'Unlike conventional quantum field theory, string theory requires gravity. I regard this fact as one of the greatest in- sights in science ever made.' But until recently, there has been a glaring weak spot: string theorists have been unable to probe all solutions of the model, failing miserably to examine what is called the 'non-perturbative region,' which I will describe shortly. This is vitally important, since ultimately our universe (with its wonderfully diverse collection of galaxies, stars, planets, sub- atomic particles, and even people) may lie in this 'non-perturbative region.' Until this region can be probed, we don't know if string theory is a theory of everything or a theory of nothing! That's what today's excitement is all about. For the first time, using a powerful tool called 'duality,' physicists are now probing beyond just the tail, and finally seeing the outlines of a huge, unexpectedly beautiful lion at the other end. Not knowing what to call it, Witten has dubbed it 'M-theory.' In one stroke, M-theory has solved many of the embarrassing features of the theory, such as why we have 5 superstring theories. Ultimately, it may solve the nagging question of where strings come from.

Albert Einstein once asked himself if God had any choice in making the universe. Perhaps not, so it was embarrassing for string theorists to have five different self-consistent strings, all of which can unite the two fundamental theories in physics, the theory of gravity and the quantum theory. Each of these string theories looks completely different from the others. They are based on different symmetries, with exotic names like E(8)xE(8) and O(32). Not only this, but superstrings are in some sense not unique: there are other non-string theories which contain super- symmetry, the key mathematical symmetry underlying superstrings. (Changing light into electrons and then into gravity is one of the rather astonishing tricks performed by supersymmetry, which is the symmetry which can exchange particles with half-integral spin, like electrons and quarks, with particles of integral spin, like photons, gravitons, and W-particles. In 11 dimensions, in fact, there are alternate super theories based on membranes as well as point particles as known as super-gravity. In lower dimensions, there is moreover a whole zoo of super theories based on membranes in different dimensions. As example, point particles are 0-branes, strings are 1-branes, membranes are 2-branes, and so on. For the p-dimensional case, some wag dubbed them p-branes (as "pea brains"). But because p-branes are horribly difficult to work with, they were long considered just a historical curiosity, a trail that led to a dead-end.

Michael Duff, in fact, has collected a whole list of unflattering comments made by referees to his National Science Foundation grant concerning his work on p-branes. One of the more charitable comments from a referee was "He has a skewed view of the relative importance of various concepts in modern theoretical physics." So that was the mystery. Why should supersymmetry allow for 5 superstrings and this peculiar, motley collection of p-branes? Now we realize that strings, supergravity, and p-branes are just different aspects of the same theory. M-theory (M for "membrane" or the "mother of all strings," take your pick) unites the 5 superstrings into one theory and includes the p-branes as well. To see how this all fits together, let us update the famous parable of the blind wise men and the elephant. Think of the blind men on the trail of the lion. Hearing it races by; they chase after it and desperately grab onto its tail (a one-brane). Hanging onto the tail for dear life, they feel its one- dimensional form and loudly proclaim "It's a string! It's a string!" Then one blind man goes beyond the tail and grabs onto the ear of the lion. Feeling a two-dimensional surface (a membrane), the blind man proclaims, "No, it's really a two-brane!" Then another blind man is able to grab onto the leg of the lion. Sensing a three-dimensional solid, he shouts, "No, you're both wrong. It's really a three-brane!" Actually, they are all right. Just as the tail, ear,

and leg are different parts of the same lion, the string and various p-branes appear to be different limits of the same theory (as M- theory). Paul Townsend of Cambridge University, one of the architects of this idea, calls it "p-brane democracy," i.e. all p-branes (including strings) are created equal. Schwarz puts a slightly different spin on this. He says, "we are in an Orwellian situation: all p-branes are equal, but some (namely strings) are more equal than others. The point is that they are the only ones on which we can base a perturbation theory." To understand unfamiliar concepts such as duality, perturbation theory, non-perturbative solutions, it is instructive to see where these concepts first entered into physics.

As we know that, the key tool to understanding this breakthrough is something 'duality.' Loosely speaking, two theories are 'dual' to each other if they can be shown to be equivalent under a certain interchange. The simplest example of duality is reversing the role of electricity and magnetism in the equations discovered by James Clerk Maxwell of Cambridge University, 130 years ago. These are the equations which govern light, TV, X-rays, radar, dynamos, motors, transformers, even the Internet and computers. The remarkable feature about these equations is that they remain the same if we interchange the magnetic B and electric fields E and also switch the electric charge e with the magnetic charge g of a magnetic 'monopole': E <–> B and e <–> g (In fact, the product eg is a constant). This has important implications. Often, when a theory cannot be solved exactly, we use an approximation scheme. In first year, calculus, for example, we can approximate certain functions by Taylor's expansion. Similarly, since $e^2 = 1/137$ in certain units and is hence a small number, we can always approximate the theory by power expanding in e^2 (known as fine-structure constant). So, we add contributions of order $e^2 + e^4 + e^6$ etc. in solving for, say, the collision of two particles. Notice that each contribution is getting smaller and smaller, so we can in principle add them all up. This generalization of Taylor's expansion is called 'perturbation theory,' where we perturb the system with terms containing e^2. For example, in archery, perturbation theory is how we aim our arrows. With every motion of our arms, our bow gets closer and closer to aligning with the bull's eye.) But now try expanding in g^2. This is much tougher; in fact, if we expand in g^2, which is large, then the sum $g^2 + g^4 + g^6$ etc. blows up and becomes meaningless. This is the reason why the 'non-perturbative' region is so difficult to probe, since the theory simply blows up if we try to naively use perturbation theory for large coupling constant g. So, at first it appears hopeless that we could ever penetrate into the non-perturbative region. For example, if every motion of our arms got bigger and bigger, we would never be able to zero in and hit the target with the arrow. But notice that because of duality, a theory of small e (which is easily solved) is identical to a theory of large g (which is difficult to solve). But since they are the same theory, we can use duality to solve for the non-perturbative region.

M. H. MacGregor has published his book 'Power of alpha (α)' in 2007 and has told 'the mystery about the fine-structure constant is actually a double mystery. The first mystery is the origin of its numerical value and has been recognized and discussed for decades. The second mystery is the range of its domain and is generally unrecognized.' His work from this time is often cited in subsequent theoretical physics and cosmology papers, particularly those discussing models of the universe and the nature of dark matter. Wolfgang Pauli was an Austrian–Swiss theoretical physicist and a pioneer of quantum mechanics has said, 'When I die my first question to the Devil will be: What is the meaning of the fine structure constant?' That's why British astronomer Sir James Jeans declared 'God is a pure mathematician!' Again, Paul Davies is an English physicist, and a professor in Arizona State University said, 'The physical universe does seem to be organized around elegant mathematical relationships. And one number above all others has exercised an enduring fascination for physicists: 137.0359991.... It is known as the fine-structure constant and is denoted by the Greek letter alpha (α).' While twentieth-century physicists were not able to identify any convincing mathematical constants underlying the fine structure, partly because such thinking has normally not been encouraged, a revolutionary suggestion was recently made by the Czech physicist Raji Heyrovska, who deduced that the fine structure constant, ...really is defined by the [golden] ratio. Carl Johan Calleman talked about the concept of 'The Purposeful Universe.'

The first suspicion that duality might apply in string theory was discovered by K. Kikkawa and M. Yamasaki of Osaka Univ. in 1984. They showed that if you 'curled up' one of the extra dimensions into a circle with radius R, the theory was the same if we curled up this dimension with radius 1/R. This is now called T-duality and which connects a string theory compactified on a circle of radius R to another string theory compactified on a circle of radius $1/R$ (in Planck units). A string moving on a small circle behaves like a string with different momentum/winding states on a large circle, and vice-versa. When applied to various superstrings, one could reduce 5 of the string theories down to 3. In 9 dimensions (with one dimension curled up) the Type IIa and IIb strings were identical, as were the E(8)xE(8) and O(32) strings. Unfortunately, T duality was still a perturbative duality. The next breakthrough came when it was shown that there was a second class of dualities, called S duality, which provided a duality between the perturbative and non-perturbative regions of string theory. It is a transformation that exchanges a string theory with a weak coupling constant (g) for another string theory with a strong coupling constant (1/g). Type IIB string theory at weak coupling is equivalent to Type IIB at strong coupling, which is related to F-theory. Another duality, called U duality, was even more powerful. It encompasses both S-duality and T-duality transformations. It reveals the interconnectedness of various string theories (Type IIA, IIB, Heterotic, etc.) and M-theory, showing they are different limits or compactifications of a single underlying theory. It used to find new black hole/brane solutions, understand BPS states (supersymmetric states), and map out the landscape of string theory vacua. Then Nathan Seiberg and Witten brilliantly showed how another

form of duality could solve for the non-perturbative region in four dimensional supersymmetric theories. However, what finally convinced many physicists of the power of this technique was the work of Paul Townsend and Edward Wit- ten. They caught everyone by surprise by showing that there was a duality between 10-dimensional Type IIa strings and 11 dimension- al supergravity! The non-perturbative region of Type IIa strings, which was previously a forbidden region, was revealed to be governed by 11-dimensional supergravity theory, with one dimension curled up. At this point, many physicists were rubbing their eyes, not believing what they were seeing. All of a sudden, they realized that perhaps the real 'home' of string theory was not 10 dimensions, but possibly 11, and that the theory wasn't fundamentally a string theory at all! This revived tremendous interest in 11 dimensional theories and p-branes. Loitering in the 11th dimension was an entirely new theory which could reduce down to 11-dimensional supergravity as well as 10-dimensional string theory and p-brane theory.

However, these mathematical developments still don't answer the nagging question: how do you test it? Since string theory is really a theory of Creation, when all its beautiful symmetries were in their full glory, the only way to test it, the critics wail, is to re-create the Big Bang itself, which is impossible. Detractors of string theory are including renowned physicists like Peter Woit, Sheldon Glashow, and Sabine Hossenfelder, largely argue that the theory lacks experimental verification and testable predictions, making it more of a mathematical framework or hypothesis than a proper scientific theory. The most significant criticism is that the phenomena predicted by string theory (such as the existence of strings themselves or super-partner particles) occur at energy scales far beyond the reach of current or foreseeable technology, like the Large Hadron Collider (LHC). This makes the theory difficult, if not impossible, to verify or falsify in practice, a core tenet of the scientific method for critics. String theory does not predict a single, unique universe with specific properties. Instead, it allows for a vast number of possible solutions (estimated at around 100^{500} different "vacua"), each describing a universe with different physical laws. Critics argue this means the theory explains everything and nothing simultaneously, as it can be tuned to match almost any observation, which limits its predictive power for our specific universe. Dependence on unproven hypotheses, the theory requires the existence of extra dimensions and supersymmetry (SUSY) for mathematical consistency. However, there is currently no experimental evidence for either of these ideas in nature, and the lack of SUSY particle discovery at the LHC has been a major disappointment for many physicists.

Nobel Laureate Sheldon Glashow likes to ridicule superstring theory by comparing it with former Pres. Reagan's Star Wars plan, i.e. they are both untestable, soak up resources, and both siphon off the best scientific brains. Some detractors, notably Lee Smolin in 'The Trouble with Physics', criticize the academic dominance of string theory, arguing it has received a disproportionate amount of funding and research positions for decades, stifling research into alternative approaches to quantum gravity like Loop Quantum Gravity. This has led to accusations of a "cult" of personality around leading string theorists and a lack of open discourse. In point of mathematical abstraction vs. physics critics argue that string theory has become an exercise in abstract mathematics rather than physics, losing its connection to empirical reality. While the theory has produced useful mathematical tools applicable in other areas of physics (like the AdS/CFT correspondence for black hole physics), these spin-offs are seen as separate from the primary goal of unifying all forces. However, whether a mathematically elegant and consistent framework is sufficient justification for a physical theory in the absence of empirical testability. Actually, most string theorists think these criticisms are silly. They believe that the critics have missed the point. The key point is this: if the theory can be solved non- perturbatively using pure mathematics, then it should reduce down at low energies to a theory of ordinary protons, electrons, atoms, and molecules, for which there is ample experimental data. If we could completely solve the theory, we should be able to extract its low energy spectrum, which should match the familiar particles we see today in the Standard Model. Thus, the problem is not building atom smashers l,000 light years in diameter; the real problem is raw brain power: if only we were clever enough, we could write down M-theory, solve it, and settle everything.

The Standard Model of particle physics is the prevailing theoretical framework describing the elementary particles and the fundamental forces through which they interact. Developed throughout the latter half of the 20th century, it is a highly successful quantum field theory that has been confirmed by numerous experiments. The Standard Model provides a robust framework for understanding the microscopic world, successfully predicting the existence of many particles before they were experimentally discovered, including the Higgs boson, which was confirmed in 2012 by researchers at CERN's Large Hadron Collider. The model describes 17 types of elementary particles (12 fermions, 4-gauge bosons, and 1 scalar boson) and three of the four known fundamental forces: the electromagnetic, strong nuclear, and weak nuclear interactions. The fourth, gravity, is not currently incorporated into the Standard Model. Quarks are fundamental constituents of matter that participate in all three fundamental forces, including the strong interaction. They combine to form composite particles called hadrons, such as protons and neutrons. There are six types, or flavors and arranged in three generations. Leptons are another class of fundamental matter particles that do not participate in the strong interaction. There are six types, also arranged in three generations. Gluons are the carrier particles (gauge bosons) of the strong nuclear force, binding quarks together to form hadrons. Electrons are the most stable and familiar of the leptons, carrying a negative electric charge and orbiting atomic nuclei. Neutrinos are elusive, weakly interacting leptons with very small mass. They interact primarily via the weak nuclear force and are extremely abundant in the universe. Higgs Boson as scalar particle is the physical manifestation of the Higgs field, which permeates all of space.

The interaction of other particles with this field is what gives them mass, a mechanism central to the Standard Model.

Now, what is the solution of M-theory and stop all the speculation and back-biting? There need to derive the Standard Model of particle interactions, with its bizarre collection of quarks, gluons, electrons, neutrinos, Higgs bosons, and many more. This might be done by curling up 6 of the 10 dimensions, leaving us with a 4-dimensional theory that might resemble the Standard Model a bit. Then try to use duality and M-theory to probe its non-perturbative region, seeing if the symmetries break in the correct fashion, giving us the correct masses of the quarks and other particles in the Standard Model. Witten's philosophy, however, is a bit different. He feels that the key to solving string theory is to understand the under-lying principle behind the theory. Einstein's theory of general relativity, started from first principles. Einstein had the "happiest thought in his life" when he leaned back in his chair at the Bern patent office and realized that a person in a falling elevator would feel no gravity. Although physicists since Galileo knew this, Einstein was able to extract from this the Equivalence Principle. This deceptively simple statement that the laws of physics are indistinguishable locally in an accelerating or a gravitating frame and that led Einstein to introduce a new symmetry to physics, general co-ordinate transformations. This in turn gave birth to the action principle behind general relativity, the most beautiful and compelling theory of gravity. Only now are we trying to quantize the theory to make it compatible with the other forces. Witten said, we need to discover the analog of the Equivalence Principle for string theory. The fundamental problem has been that string theory has been evolving "backwards." Witten also added, "string theory is 21st century physics which fell into the 20th century by accident." We were never "meant" to see this theory until the next century.

In theoretical physics, F-theory (where F for father) is a branch of string theory developed by Iranian-American physicist Cumrun Vafa. He added a strange twist to this when he introduced yet another mega-theory, this time a 12-dimensional theory and that explains the self-duality of the IIb string. Unfortunately, this 12-dimensional theory is rather strange: it has two-timed co-ordinates, not one, and actually violates 12-dimensional relativity. Imagine trying to live in a world with two times! It would put an episode of Twilight Zone to shame. Now, the question is the final theory 10, 11, or 12 dimensional? Schwarz feels that the final version of M-theory may not even have any fixed dimension. He feels that the true theory may be independent of any dimensionality of space-time, and that 11 dimensions only emerges once one tries to solve it. He feels that the true theory may be independent of any dimensionality of space-time, and that 11 dimensions only emerges once one tries to solve it. Townsend seems to agree, saying 'the whole notion of dimensionality is an approximate one that only emerges in some semiclassical context.' Question is, does this means that the end is in sight, that we will someday soon derive the Standard Model from first principles? Today's physicists are enthusiastic supporters of this revolution, they are still cautious about predicting the future. Townsend believes that we are in a stage similar to the old quantum era of the Bohr atom, just before the full elucidation of quantum mechanics. He says, 'We have some fruitful pictures and some rules analogous to the Bohr-Sommerfeld quantization rules, but it's also clear that we don't have a complete theory.'

The large number of semirealistic solutions to string theory referred to as the string theory landscape, with 10^{272000} elements or so, is dominated by F-theory compactifications on Calabi–Yau four-folds. There are at least 10^{15} of those solutions consistent with the Standard Model of particle physics. Duff says, 'is M-theory merely a theory of super-membranes and super 5-branes requiring some as yet unknown non-perturbative quantization, or (as Witten believes) are the underlying degrees of freedom of M-theory yet to be discovered? I am personally agnostic on this point.' Witten certainly believes we are on the right track, but we need a few more 'revolutions' like this to finally solve the theory. Witten said, 'we still know very little about what string theory is, and this implies that it remains an excellent subject for young physicists to start to work on. I suspect he sees all too well that among physicists the tide has changed, with students turning to other subjects as jobs in string theory dry up and prospects for progress on string theory unification look increasingly dismal. He's trying to counter this by restating the arguments that have continued to keep him interested in the subject.' He also added, 'I think there are still a couple more superstring revolutions in our future, at least. If we can manage one more superstring revolution a decade, I think that we will do all right.' Vafa said, 'I hope this is the 'light at the end of the tunnel' but who knows how long the tunnel is!' Schwarz has written about M-theory as 'whether it is based on something geometrical (like super-membranes) or something completely different is still not known. In any case, finding it would be a landmark in human intellectual history.' He also added, 'personally, I am optimistic. For the first time, we can see the outline of the lion, and it is magnificent. One day, we will hear it roar.'

4. Warp Machine Physics

As we know that, the Warp Drive is a faster-than-light spacecraft propulsion system that is used in some of Science Fiction, such as Star Trek. Again, the spacecraft equipped with the WARP machine can move faster than light. In the study of the Warp machine, the researchers proposed many ideas in physics. Those concepts are dark energy, general relativity of Albert Einstein, which predicts strange but real phenomena in the world, such as the bending of space-time and gravitational waves, the theory of "M". Ultimately, the result is that nothing can move in the vacuum faster than light. The report, which claims the car could be possible, says in the report: "If the concept of interstellar exploration really has to be realized in the lifetime of a human being, then it needs to make a fundamental change in the traditional approach and move towards the spacecraft propulsion. Removal." In the study, a table of various purposes has been mentioned, and it is said when, by bending space-time for traveling at 100 times the speed of light to those purposes. This can be achieved by using a significant amount of dark energy

to expand the extra dimension into a bubble. Such a bubble will be large enough to accommodate a spacecraft of 100 cubic meters, a space-time space in front of the spacecraft, plus an extension region behind it that propels the bubble, without violating the speed of light, creates a space-time pipe. "It's impossible to move beyond the speed of light, but it can be imagined that space-time bending is effective," Carroll said. For example, if you want to go to Alpha Centaurus, you can ask yourself: Well, can I bend the space-time to distance with Alpha Centauri in a short time? Can I do something with the bending of space-time so that such a thing can come true? Well, the answer is yes you can. But there are things called the caraper, extra dimensions, the effect of a casimir, dark energy, and so on. All this is true. But it's probably zero that someone in the present or a thousand years later can make something right to exploit these ideas, whether for defense or anything else. "

There are many difficulties and dangers of traveling faster than light. Carroll went on to say: "Warp machine was dropped out of probable reality, because nobody knows what negative energy it is, how it can be made, how it can be stored, or how it can be used. In addition, the amount of energy needed to reach a point such as Alpha Centauri, which is the closest stellar planet to Earth, is located at 4.3367 light years, with a truly astronomical 100-cubic spacecraft. Take the whole earth and turn it into energy. This is the amount of energy you need to make the trip possible, with the exception that you need a negative amount and nobody knows how to build it. It should save this energy and use it with 100% return. It's really crazy. It's not that easy to say with better transistors this can be done. There is nothing to be easily achieved." Of course, experimental achievements in a large Hadron Collider or advances in the theory of M can enhance our understanding of this strange kind of energy and lead us to lead to major technology innovations. The large Hadron Collider still does not find evidence of particles that could reveal the secret of dark energy, and experiments have not made progress in the theory of M so far. Intermediate stars may soon lose control of their spacecraft and destroy their spacecraft immediately after their journey began.

In August 2008, the Department of Defense gathered several scholars to examine some of the aerospace technologies, such as unprecedented propulsion, lift and camouflage techniques, according to the Big Bang report. The researchers produced a 34-page report entitled "Warp Machine, Dark Energy, and Manipulation of Additional Dimensions." Although this documentary dates back to April 2, 2010, the Defense Intelligence Agency recently released it. According to the researchers, we may not have much to do with the mysteries of unknown dimensions or dark energy. Researchers believe that dark energy is the force that makes the universe more rapidly expanded. In this report, we see: "Control of this multidimensional space may be the field for controlling the density of dark energy. And ultimately play a role in the development of propulsion technologies or the car of the car. The journey to the planets of the Solar System takes only a few hours, not years old. Also, traveling to the local star system is measured in the week, not hundreds of thousands of years. "However, Sean Carroll, a theoretical physicist at Caltech who follows and studied the issues related to this report, points out "In this report, we see works of theoretical physics that seem to relate to real world applications, but not so. This is not a strange thing, and it is far from the Maharish claim that it is supposed to use the energy of the soul to fly from the earth. This report refers to real physics. But so soon we should not see the connection with engineering." James T. Lakatsky, who contributed to the drafting of the report, did not respond to the questions posed by Business Insider.

The United States Air Force facility has known as Area 51 and which is located in Reid's home state of Nevada. In the 1970s, after revived interest in the '1947 Roswell UFO incident', Area 51 was rumoured by ufologists and conspiracy theorists to be the US government's storage location for the crashed alien craft for study. So, the US military may predict some hostile technologies. It includes a series of advanced technology reports entitled Advanced Aerospace Weapons Applications (AAWSAP). The program also included a major project called Advanced Aid Identification Program (AATIP), in which the military personnel were responsible for reviewing reports of UFOs. It was an unclassified but unpublicized investigatory effort funded by the United States Government to study unidentified flying objects (UFOs) or unexplained aerial phenomena (UAP). Scientists have a dubious view about anonymous bird objects, even after seeing the many videos that are being made available. In one case, a person with his camera has captured a scene in which a spacecraft that shines brightly at very high speeds. A senior astronomer Seth Shostak believes we will find ET in the next two decades. Seth at Sestie Institute, or 'Extraterrestrial Intelligence', had previously told Business Insider that after 50 years of various reports about observing extraterrestrial organisms, there was still strong evidence that really these creatures had visited us. He said, 'Finding life beyond Earth would be like giving neanderthals access to the British Museum; we could learn so much from a society that is more advanced than ours, and it would calibrate our own existence.' Work is never boring for Shostak, discoveries are being made all the time and technology advances every year, which keeps things exciting. It's odd that extraterrestrials do not have to do hundreds of light years to reach the ground. In an extensive program that looked at the possibility of paying for Machine Warp, Wormholes and Star Trek, expert experts performed careful inquiries.

5. Concept and Analysis of God Equation or Theory of Everything

Michio Kaku was a famous theoretical physicist and the concept of the 'God Equation' or the 'Theory of Everything' (ToE). Kaku is an Armenian theoretical scientist and co-founder of 'String Field Theory'. He told everything in the universe particles, forces, matter, energy as well as that it made up of tiny vibrating strings. This theory could be the God equation. It may explain the origin, design and fate of the universe. It is still not proven, but it is the leading theme and tidal framework. God Equation is not the religious term, rather it is metaphorical. As we know that, Great scientist

Einstein spent his life searching for a unified theory and reformed to it as discovering 'God's thought.' Futurist and physicist Michio Kaku is the author of the book 'The God Equation' which published in 2017. It was a popular science book. In this book he explores few interesting texts like, history of physics; the quest to unity all the fundamental forces of nature under one single theory: the idea that the universe runs on a mathematical code and that code may be described by what Einstein called the 'God Equation.' Kaku explores the history of unification theories of physics starting with Newton's law of universal gravitation which unified our experience of gravity on Earth and the motions of the celestial bodies to Einstein's general relativity and quantum mechanics and the standard model. He dubs the final Grand Unified Theory and quantum gravity the God Equation with an 11-dimensional string theory as the only self-consistent theory that seems to fit the bill. Again, hypothetical single, which encompass everything so all, coherent theoretical frameworks of physics and that is known as ToE.

The ToE invites all four fundamental forces of nature. Again, general relativity explains gravity and that is big things. On the other hand, QM explains atoms and that is small things and the ToE would unify them. String theory, which incorporates an 11-dimensional framework in one of its primary formulations or M-theory, is currently considered the most mathematically consistent candidate for this ultimate equation. A ToE is a hypothetical framework in physics that aims to unify all fundamental forces and elementary particles into a single, coherent model, explaining all known physical phenomena from the large-scale universe to the subatomic level. It would reconcile the two pillars of modern physics, general relativity and quantum mechanics, and explain the four fundamental forces like gravity, electromagnetism, the strong nuclear force, and the weak nuclear force. The ToE seeks to describe how gravity, electromagnetism, the strong nuclear force, and the weak nuclear force are all different aspects of a single underlying interaction. It is a central goal, as these two theories currently describe reality at different scales and are incompatible in their current forms. A complete theory would ideally explain phenomena like dark matter and dark energy, which make up the majority of the universe but are not accounted for by the Standard Model of particle physics. Some discussions extend the concept to a philosophical ToE that seeks to explain all aspects of reality, including consciousness, from a single principle. The search for a ToE is a long-standing, central goal in theoretical physics.

The existence of a singular 'final theory' is also debated, with some suggesting that the universe may not be describable by a single theory. GR and QM have been frequently validated in their separate fields of application. Since the usual areas of applicability of GR and QM are so different, most situations require that only one of the two theories can be used. The two theories are considered mismatched in regions of extremely small scale and the Planck scale; like those, which exist within a black hole or during the beginning stages of the universe or the moment immediately following the Big Bang. To resolve the incompatibility, a theoretical framework revealing a deeper underlying reality, unifying gravity with the other three interactions, and which must be discovered to harmoniously integrate the realms of GR and QM into a seamless whole. So, a theory of everything may be defined as a comprehensive theory that, in principle, would be capable of describing all physical phenomena in the universe. In pursuit of this goal, quantum gravity has become one area of active research. One example is string theory, which evolved into a candidate for the ToE, but not without drawbacks. Particularly, its deceptive lack of currently testable predictions and controversy. String theory posits that at the beginning of the universe up to 10^{-43} seconds after the Big Bang, the four fundamental forces were once a single fundamental force. According to string theory, every particle in the universe, at its most ultramicroscopic level (or Planck length), consists of varying combinations of vibrating strings (or strands) with preferred patterns of vibration. String theory further claims that it is through these specific oscillatory patterns of strings that a particle of unique mass and force charge is created. The electron is a type of string that vibrates one way, while the up quark is a type of string vibrating another way, and continue. String theory or M-theory proposes six or seven dimensions of spacetime in addition to the four common dimensions for a 10 or 11-dimensional spacetime.

The universe is governed by 'laws of physics. To truly understand what it is why it exists and how it works, physicists seek answers to questions such as: What is the universe made of? How did it begin? Why are the laws of physics so precise? Is there a deeper, unified law behind everything? Interestingly, a 'theory of everything' is a single framework that explains all physical aspects of the universe from galaxies to subatomic particles. Gravity mainly governs planets, stars, galaxies, etc. Electromagnetism mainly governs light, electricity. Again, strong force holds atomic nuclei and weak force radioactive decay. On the other hand, 'The God Equation' is a journey through physics history, aiming to answer the big question, 'Can we find a single mathematical formula that explains the universe and the mind of God'. Einstein called the search for unity 'knowing the mind of God'. Kaku honours this metaphor and it is not religious, but symbolic of the ultimate truth. Kaku brings the new idea as String theory. He told; all particles are made of tiny vibrating strings. So different vibration = different particles. Think of it like strings on a violin; so different notes = different particles. String theory naturally includes gravity and quantum mechanics. Kaku said, 'The universe is a symphony of strings. The mind of God is cosmic music resonating through 11-dimensional hyperspace. Science is the engine of prosperity. But it also answers the biggest philosophical questions.'

So, in the beginning, the universe was a formless quantum fog. Then came the Big Bang as space, time and matter exploded into being. Physicists like Newton, Maxwell, Einstein, and now Kaku, have tried to decode this reality. While Einstein unified some forces, he could not finish the job. Kaku picks up where he left off - believing that tiny vibrating strings, living in hidden dimensions, hold the key. If found, this 'God Equation,'

would be the ultimate achievement in science as a single elegant truth that explains everything from black holes to atoms, time to consciousness. Timeline of the universe according to physics is really interesting. The universe began from a singularity and that is 13.8 billion years ago. The universe expanded faster than light. Atoms formed after 380,000 years. Star and galaxies formed gravity 1 billion years later. Lastly, humans appeared only in the last few seconds of cosmic time. Michio Kaku believes the future lies in mastering this timeline like space travel, longevity and consciousness. He thought 10-11 dimensions exist where 6+ are 'curled up'. Every particle has a 'super partner.' String Theory says, So, in simple word, 'Everything is made of vibrating strings.' Whereas 'Loop Quantum Gravity,' says, space-time itself is quantized. Again, 'Causal Dynamical Triangulations' says, universe is a growing network. On the other hand, 'Emergent Gravity' says, gravity is not fundamental, but emerges. Kaku links ToE to our future survival. He went to say that, ToE will help to solve climate change, pandemics, AI ethics in short-term. ToE is going to becoming a Type I civilization in mid-term. Again, ToE is & will going to becoming a Type II or III civilization and harnessing the power of stars and galaxies.

So, it may say that, the universe is mathematical. At its core, reality appears to be governed by elegant, mathematical rules. The 'God Equation' would be a single formula that expresses all of nature. Michio Kaku believes this equation already exists in string theory, but we have not fully solved it yet. So, we are made of vibrating strings and our consciousness may be a product of cosmic level design. Human life is not random; rather structured. On the other hand, in the multiverse model, countless universes exist. Only a few have the right physical laws for life. We exist because this universe is "tuned" to allow consciousness. Kaku said, "we observe a universe suited for life -- because we are here to observe it." Kaku believes our ultimate destiny is to understand the universe. And to become creators ourselves. And to become a multi-planetary (Type I or II) civilization. Again, modern theory suggests: The Big Bang may not have been the beginning. Time and space might emerge from deeper laws, like strings or branes colliding. The God Equation could reveal what existed before time began. Michio Kaku said, 'we have not yet figured out why there is more matter than antimatter in the universe. Only one ten-billionth of the original matter in the early universe survived this explosion, and we are part of it. The leading theory is that something violated the perfect symmetry between matter and antimatter at the Big Bang, but we don't know what it is. There is a Nobel Prize waiting for the enterprising individual who can solve this problem.'

Michio Kaku also said, 'there was only one period of time when energy on this enormous scale was readily available, and that was at the instant of creation. In fact, the hyperspace theory cannot be tested by our largest atom smashers because the theory is really a theory of creation. Only at the instant of the Big Bang do we see the full power of the hyperspace theory coming into play. This raises the exciting possibility that the hyperspace theory may unlock the secret of the origin of the universe.' He added an interesting fact as, 'David Eagleman describes how you can take a male stickleback fish and have a female fish trespass on its territory. The male gets confused, because it wants to mate with the female, but it also wants to defend its territory. As a result, the male stickleback fish will simultaneously attack the female while initiating courtship behaviour. The male is driven into a frenzy, trying to woo and kill the female at the same time. This works for mice as well. Put an electrode in front of a piece of cheese. If the mouse gets too close, the electrode will shock it. One feedback loop tells the mouse to eat the cheese, but another one tells the mouse to stay away and avoid being shocked. By adjusting the location of the electrode, you can get the mouse to oscillate, torn between two conflicting feedback loops.'

Kaku said, 'in fact, there is one theory that states that dark matter, an invisible form of matter that surrounds the galaxy, might be ordinary matter floating in a parallel universe. As in H.G. Wells's novel The Invisible Man, a person would become invisible if he floated just above us in the fourth dimension. Imagine two parallel sheets of paper, with someone floating on one sheet, just above the other. In the same way there is speculation that dark matter might be an ordinary galaxy hovering above us in another membrane universe. We could feel the gravity of this galaxy, since gravity can ooze its way between universes, but the other galaxy would be invisible to us because light moves underneath the galaxy. In this way, the galaxy would have gravity but would be invisible, which fits the description of dark matter. (Yet another possibility is that dark matter might consist of the next vibration of the superstring. Everything we see around us, such as atoms and light, is nothing but the lowest vibration of the superstring. Dark matter might be the next higher set of vibrations.)' He also said, 'In other words, positive matter and energy that we see in stars can warp space-time so that it perfectly describes the motion of heavenly bodies. But negative matter and energy warp space-time in bizarre ways, creating an antigravitational force that can stabilize wormholes and prevent them from collapsing and propel warp bubbles to faster-than-light velocities by compressing space-time in front of them.'

So, the universe needs observers to give it meaning. We are the ones trying to decode its blueprint. And that is the 'God Equation.' Once we do, we may answer the oldest questions like: Why do we exist? What is the purpose of life? Was this all by chance or design or structured? So, the universe, its creation, and its future are filled with astonishing mind-bending facts, both from science and philosophical reflection. Universe had a beginning, but not from nothing. Big Bang says, the universe began ~13.8 billion years ago. Space, time, energy and matter all came into existence in an instant. But modern theories like M-Theory (or Multi-Verse Theory) suggest, the Big Bang might have been a transition, not a beginning; possibly a collision of higher-dimensional 'branes' (membranes). The fundamental constants (gravity, electromagnetism, etc) are so precise that even a tiny variation would make life impossible. Kaku and others says, we live in a universe that must allow observers like us to exist. Again the multi-

verse theory says there could be infinite parallel universes, each with different physical laws. Ours just happens to support stars, chemistry, and life. New universes may be budding off from black holes or via quantum fluctuations. Time flows forward for us; but in relativity time is relative, bendable. In quantum physics, some processes are timeless. The future, past and present may be illusions of perception, not absolute truths.

Once Michio Kaku said, 'First, to create the violent distortions of space and time necessary to travel through a wormhole, one would need fabulous amounts of positive and negative matter, on the order of a huge star or a black hole.' Matthew Visser, a physicist at Washington University, evaluates that the amount of negative energy we would need to open up a 1-meter wormhole is comparable to the mass of Jupiter, except that it would need to be negative. He said, 'You need about minus one Jupiter mass to do the job. Just manipulating a positive Jupiter mass of energy is already pretty freaky, well beyond our capabilities into the foreseeable future.' Again, Kaku said, 'If we had a microscope powerful enough, we could see that electrons, quarks, neutrinos, etc. are nothing but vibrations on minuscule loops resembling rubber bands. If we pluck the rubber band enough times and in different ways, we eventually create all the known subatomic particles in the universe. This means that all the laws of physics can be reduced to the harmonies of these strings. Chemistry is the melodies one can play on them. The universe is a symphony. And the mind of God, which Einstein eloquently wrote about, is cosmic music resonating throughout space-time.'

The universe is conscious of itself. All atoms in your body came from stars. Consciousness may be a byproduct of brain evolution. Or possibly a fundamental part of the universe as some theories suggest. Another concept is 'Big Freeze' and it means, universe expands forever, stars die, cold and dark. 'Big Crunch' says, gravity reverses expansion, universe collapses. 'Heat Death' says, maximum entropy: no energy left to do work. 'Big Rip' says, expansion accelerates infinitely, tearing everything apart. 'Eternal Inflation' says new universes keep forming forever. So we are not alone. In our universe we have 2 trillion galaxies. Each galaxy has billions of stars; many stars have Earth-like planets. Statistically life should exist elsewhere and yet we have found none. And this is known as 'Fermi Paradox.' So, Human destiny is to become any or many types of civilization. That is the thinking of Michio Kaku.

- **Type zero** means we use fossil fuels. Michio Kaku uses the term 'Type Zero civilization' in the context of the Kardashev Scale to describe the current state of human civilization. He posits that humanity is a Type Zero civilization because we still primarily rely on dead or fossil fuels to power our society, drawing energy from sources outside our planet.
- **Type I Civilization** (Planetary): Type I means we use 100% of planet's energy. It is capable of harnessing and storing all the energy that reaches its home planet from the sun. Kaku suggests humanity may reach this stage within a century or two. So, it may come 100 to 200 years later. As per Michio Kaku, 'Future of Humanity - Planetary Civilization. In mythology, the gods lived in the divine splendour of heaven, far above the insignificant affairs of mere mortals. The Greek gods frolicked in the heavenly domain of Mount Olympus, while the Norse gods who fought for honour and eternal glory would feast in the hallowed halls of Valhalla with the spirits of fallen warriors. But if our destiny is to attain the power of the gods by the end of the century, what will our civilization look like in 2100? Where is all this technological innovation taking our civilization? All the technological revolutions described here are leading to a single point: the creation of a planetary civilization. This transition is perhaps the greatest in human history. In fact, the people living today are the most important ever to walk the surface of the planet, since they will determine whether we attain this goal or descend into chaos. Perhaps 5,000 generations of humans have walked the surface of the earth since we first emerged in Africa about 100,000 years ago, and of them, the ones living in this century will ultimately determine our fate. Unless there is a natural catastrophe or some calamitous act of folly, it is inevitable that we will enter this phase of our collective history. We can see this most clearly by analysing the history of energy.'
- **Type II Civilization** (Stellar): Type II civilization means, we may harness power of an entire star. It is capable of harnessing the total energy output of its home star, potentially using megastructures like a Dyson sphere. These civilizations operate on a stellar, not planetary, scale, possessing the ability to engineer planets, manipulate orbits, and achieve a post-scarcity abundance through mastery of stellar energy. A Type II civilization commands an immense power source, capturing the total energy output of its star, which is on the order of 10^{28} watts. The most iconic concept is the Dyson sphere, a hypothetical shell or swarm of structures that completely surrounds a star to capture its energy. Such a civilization would have the technology to manipulate planets, alter orbits using gravity, and potentially perform black hole engineering. They would have mastered advanced communication, possibly using quantum networks for instant thought sharing across their solar system. Reaching this stage requires planetary unification, long-term peace, and a high degree of ethical and risk management maturity to safely handle such immense power.
- **Type III Civilization** (Galactic): Type III civilization means we may use energy of the whole galaxy. It is capable of harnessing the energy output of its entire galaxy, likely through advanced technologies like self-replicating probes and colonization of star systems. A Type III Civilization, as described by the Kardashev Scale, represents the pinnacle of intelligent life in the universe. Unlike us, still at Type 0 (barely harnessing Earth's resources), or even a future Type I or II, a Type III civilization would command the full power of an entire galaxy. Imagine beings capable of extracting energy from billions of stars, controlling the immense power of black holes, and even bending spacetime itself to enable faster-than-light interstellar travel. Such a civilization would be beyond our comprehension — their

technology appearing as magic to us. A Type 3 civilization could extract energy from a supermassive black hole. This captured energy could meet the extraordinary needs of a civilization that requires up to 10^{46} W/s. The energy would be captured in the form of radiation emitted by the matter rushing into the star, by means of collectors located within the accretion disk (similar to Dyson spheres). The overflow, as well as the waste of the civilization, would be redirected towards the black hole. A fraction of this energy, directed as a high-powered beam, could be useful for space travel. A galactic club of civilizations could transmit the energy through networks within the galaxy. Within the various central power stations that make up the network, power transmission is periodically switched between transmitter and receiver, according to the galactic rotation. To be efficient, this network should be located at the centre of the galaxy. They may also use black holes as computers.

So, the universe is not just a cold machine. It is a profound mystery and we are the mechanism by which it tries to understand itself. Kaku explores these concepts in detail in his books, such as 'The Future of Humanity' and 'Physics of the Future', suggesting that reaching these stages represents an "insurance policy" against extinction and our ultimate fate in the cosmos. He said, 'Of all the transitions, perhaps the most difficult is the transition from Type 0 to Type I, which we are undergoing at present. This is because a Type 0 civilization is the most uncivilized, both technologically and socially. It has risen only recently from the swamp of sectarianism, dictatorship, and religious strife, et cetera. It still has all the scars from its brutal past, which was full of inquisitions, persecutions, pogroms, and wars. Our own history books are full of horrid tales of massacres and genocide, much of it driven by superstition, ignorance, hysteria, and hatred.' He also added, 'Each of the genes of the human body is spelled out explicitly in this dictionary, but what each does is still largely a mystery.' Michio Kaku also said, 'Today the leading (and only) candidate for a theory of everything is string theory. But, again, a backlash has arisen. Opponents claim that to get a tenured position at a top university you have to work on string theory. If you don't you will be unemployed. It's the fad of the moment, and it's not good for physics. I smile when I hear this criticism, because physics, like all human endeavours, is subject to fads and fashions. The fortunes of great theories, especially on the cutting edge of human knowledge, can rise and fall like hemlines. In fact, years ago the tables were turned; string theory was historically an outcast, a renegade theory, the victim of the bandwagon effect.'

Michio Kaku said, 'Galileo believed that science and religion could coexist. He wrote that the purpose of science is to determine how the heavens go, while the purpose of religion is to determine how to go to heaven. In other words, science is about natural law, while religion is about ethics, and there is no conflict between them as long as one keeps this distinction in mind. But when the two collided during his trial, Galileo was forced to recant his theories under pain of death. His accusers reminded him that Giordano Bruno, who had been a monk, had been burned alive for making statements about cosmology far less elaborate than his. Two centuries would pass before most of the ban on his books was finally lifted.' He added, 'There are an estimated 100 billion neurons residing inside the skull with an exponential amount of neural connections.' He also said about himself as, 'to myself I seem to have been only like a boy playing on a seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.' Physicist Alan Guth of MIT is known as one of the originators of the inflationary universe theory, has even computed the energy necessary to create a baby universe in the laboratory. Where, the temperature is 1,000 trillion degrees, which is within the range of these hypothetical civilizations. Again, until someone actually makes contact with an advanced civilization, all of this amounts as speculated and tempered with the laws of physics, no more than a useful guide in our search for extra-terrestrial intelligence. But one day, many of us may observed at the compendium, which will be containing with many coordinates, even it may be hundreds of earth-like planets in our sector of the galaxy.

6. Concept on the End of the Universe and Critical Challenges

Big Bang nucleosynthesis. Big Bang nucleosynthesis is considered as the theory of the formation of the elements in the early universe. It has ended when the universe was about three minutes old and its temperature has released below that at which nuclear fusion could occur. It had a brief period during which it could operate, so that the very lightest elements were produced. Starting from hydrogen ions or protons, it primarily produced deuterium, helium-4, and lithium and other elements were produced in only trace abundances. The elementary theory of nucleosynthesis was developed in 1948 by George Gamow, Ralph Asher Alpher, and Robert Herman. Interestingly, which was used for many years as a probe of physics at the time of the Big Bang, as the theory of Big Bang nucleosynthesis connects the abundances of primordial light elements with the features of the early universe. Precisely, it can be used to test the equivalence principle, to probe dark matter, and test neutrino physics. Some cosmologists have proposed that Big Bang nucleosynthesis proposes there is a fourth "sterile" species of neutrino. Understanding the formation and evolution of the largest and earliest structures, like quasars, galaxies, clusters and superclusters and which was one of the largest efforts in cosmology. Cosmologists study a model of hierarchical structure formation in which structures form, from the bottom up, with smaller objects forming first, while the largest objects, like superclusters, are still accumulating. One way to study structure in the universe is to survey the visible galaxies, in order to construct a 3-dimensional picture of the galaxies in the universe and measure the matter power spectrum. This is the approach of the Sloan Digital Sky Survey and the 2dF Galaxy Redshift Survey. Another tool for understanding structure formation is simulations, which cosmologists use to study the gravitational aggregation of matter in the universe, as it clusters into filaments, superclusters and voids. Most simulations contain only non-

baryonic cold dark matter, which should suffice to understand the universe on the largest scales, as there is much more dark matter in the universe than visible baryonic matter. More advanced simulations are starting to include baryons and study the formation of individual galaxies. Cosmologists study these simulations to see if they agree with the galaxy surveys, and to understand any inconsistency.

The Big Bang nucleosynthesis indicate that, the cosmic microwave background, structure formation, and galaxy rotation curves suggests that about 23% of the mass of the universe consists of non-baryonic dark matter, whereas only 4% consists of visible, baryonic matter. Today the gravitational effects of dark matter are well understood, as it behaves like a cold, non-radiative fluid that forms haloes around galaxies. As we know that, dark matter has never been detected in the laboratory, as well as the particle physics nature of dark matter remains entirely unknown. However, without observational constraints, there are a number of candidates. Such as: a stable supersymmetric particle, a weakly interacting massive particle, a gravitationally-interacting massive particle, an axion, and a massive compact halo object. Alternatives to the dark matter hypothesis include a modification of gravity at small accelerations (MOND) or an effect from brane cosmology. TeVeS is a version of MOND that can explain gravitational lensing. Again, Modified Newtonian dynamics (MOND) is a theory that proposes a modification of Newton's laws to account for observed properties of galaxies. MOND was developed in 1982 and presented in 1983 by Israeli physicist Mordehai Milgrom. Modifying Newton's law of gravity results in modified gravity, while modifying Newton's second law results in modified inertia. The latter has received little attention compared to the modified gravity version. Its primary motivation is to explain galaxy rotation curves without invoking dark matter, and is one of the most well-known theories of this class.

If we consider the universe is flat, then there must be an additional component, which making up 73% of the energy density of the universe in addition to the 23% dark matter and 4% baryons. And which is known as dark energy. In order not to interfere with Big Bang nucleosynthesis and the cosmic microwave background, it must not cluster in haloes like baryons and dark matter. There is strong observational indication for dark energy, as the total energy density of the universe is known through constraints on the flatness of the universe. However, the amount of clustering matter is tightly measured, and is much less than this. The case for dark energy was strengthened in 1999, and measurements demonstrated that the expansion of the universe has begun to gradually accelerate. Apart from its density and its clustering properties, nothing is known about dark energy. Quantum field theory predicts a cosmological constant (CC) and that is similar to dark energy, but 120 orders of magnitude larger than that observed. Steven Weinberg and a number of string theorists have appealed the 'weak anthropic principle.' Here, the reason that physicists observe a universe with such a small cosmological constant is that ‘no physicists or life could exist in a universe with a larger cosmological constant. However, many cosmologists find this an unsettled explanation, as the weak anthropic principle is self-evident- it does not attempt to explain the context of that universe. As we know that where living observers exist, there must be at least one universe with a cosmological constant (CC) which allows for life to exist. A better understanding of dark energy is likely to solve the problem of the ultimate fate of the universe. Again, in the current cosmological epoch, the accelerated expansion due to dark energy is avoiding structures larger than superclusters from forming. It is not known whether the acceleration will continue forever, perhaps even increasing until a Big Rip, or whether it will eventually reverse, lead to a Big Freeze, or may follow something else.

Still today physics has no satisfactory answer, whether primordial black holes were formed in our universe, and what happened to them. So, cosmologists need to perceive cosmic rays with energies above the GZK cutoff, and whether it signals a failure of special relativity at high energies. Again, the Greisen–Zatsepin–Kuzmin (GZK) limit or cutoff is a theoretical upper limit on the energy of cosmic ray protons traveling from other galaxies through the intergalactic medium to our galaxy. They need to find out the equivalence principle, whether or not Einstein's general theory of relativity is the accurate theory of gravitation, and if the fundamental laws of physics are the same everywhere in the universe. Additionally, cosmologists need to clear the explanation of Biophysical cosmology and which is a type of physical cosmology that studies and understands life as part as well as an inherent part of physical cosmology. It stresses that life is inherent to the universe and therefore frequent. , Several possible futures have been predicted by different scientific hypotheses, including that the universe might have existed for a finite or infinite duration, or towards explaining the manner and circumstances of its beginning. The fate of the universe may be determined by its density. The preponderance of evidence to date, based on measurements of the rate of expansion and the mass density, favors a universe that will continue to expand indefinitely, resulting in the "Big Freeze" scenario below. So, the observations are not conclusive, and alternative models are still possible. Choosing among these challenging scenarios is done by 'weighing' the universe, for example, measuring the relative contributions of matter, radiation, dark matter, and dark energy to the critical density. More precisely, contending scenarios are evaluated against data on galaxy clustering and distant supernovas, and on the anisotropies in the cosmic microwave background.

Big Freeze or Heat Death. The creation or formation of the universe may be determined by a struggle between the momentum of expansion and the pull or push of gravity. The current rate of expansion can be measured by the Hubble Constant, while the strength of gravity depends on the density and pressure of the matter in the universe. If the pressure of the matter is low, as is the case with most forms of matter as we know, then the fate of the universe is governed by the density. On the other hand, if the density of the universe is less than the critical density, then the universe will expand forever, like the different curves. Gravity might slow

the expansion rate down over time, but for densities below the critical density, there isn't enough gravitational pull from the material to ever stop or reverse the outward expansion. This is known as the Big Chill or Big Freeze; because the universe will slowly cool as it expands until eventually it is unable to sustain any life. It is a scenario under which continued expansion results in a universe that asymptotically approaches absolute zero temperature. In such scenario, the universe eventually reaches a state of maximum entropy, in which everything is evenly distributed and there are no energy gradients and which are needed to sustain information processing, and that is one form of life. In this scenario, stars are expected to form normally for 10^{12} to 10^{14} (1 to 100 trillion) years, but eventually the supply of gas needed for star formation will be exhausted. As existing stars run out of fuel and cease to shine, the universe will slowly and inexorably grow darker. Eventually black holes will dominate the universe, but they will disappear over time as they emit Hawking radiation. Over infinite time, there could be a spontaneous entropy decrease by the Poincaré recurrence theorem, thermal fluctuations, ' and the fluctuation theorem. '

The heat death scenario is compatible with any of the three spatial models, but it requires that the universe reaches an eventual temperature minimum. Without dark energy, it could occur only under a flat or hyperbolic geometry. It could also occur in a closed universe with a positive cosmological constant. Physicist Freeman Dyson has proposed a scenario for the far future in which intelligent life could achieve a form of immortality by processing an infinite number of thoughts in his 1979 paper 'Time Without End: Physics and Biology in an Open Universe'. This concept, known as 'Dyson's eternal intelligence,' and was originally predicated on an open universe, and a cosmological model that expands forever. In the context of a zero cosmological constant (as a flat or open universe without dark energy), the universe would continue to cool as it expands, but at a decelerating rate. Dyson's idea was that intelligent beings could store a finite amount of energy and expend it in increasingly smaller fractions. After each expenditure of energy for thought processes, these beings would enter a state of hibernation for immense periods, allowing the universe to cool further. As the ambient temperature of the universe drops, the minimum energy required for a computation also decreases, theoretically allowing for an infinite number of thoughts to be processed over an infinite subjective time, even with a finite energy reserve. However, this scenario faces challenges, as the discovery of an accelerating expansion, driven by a positive cosmological constant, suggests that the universe will not continue to cool indefinitely and distant regions will become causally disconnected, which would prevent the indefinite survival envisioned by Dyson.

Big Rip. It may be explained as a future where the universe, all too soon, tears itself apart. First come the clusters, with their galaxies pulled away from each other. Subsequently the galaxies dissolve and then the star systems as well as the planets. Finally, the atoms themselves. Eventually, space-time is torn asunder, rendering the universe uninhabitable and rundown. This is may be a possible future and which known as the Big Rip. Such sounds scary and almost impossible to imagine, but the truly dismaying part is that some evidence seems to be pointing directly toward that fate of us. In cosmology, the Big Rip is a hypothetical cosmological model concerning the ultimate fate of the universe, in which the matter of the universe, from stars and galaxies to atoms and subatomic particles, is increasingly torn apart by the gravitational influence of dark energy at a certain time in the future, such that distances between particles infinitely increase. It is a hypothetical, catastrophic end to the universe where the accelerating expansion of space becomes so powerful that, it overcomes all other forces, eventually tearing apart all structures. In this scenario, galaxy clusters, galaxies, solar systems, planets, and ultimately atoms and subatomic particles would be ripped apart. The process occurs if dark energy becomes stronger over time or 'a form sometimes called phantom energy,' leading to a violent and complete dissolution of all matter.

Big Rip theory is based on the idea that dark energy, which drives the universe's expansion, could increase in strength over time. The first effect would be galaxy clusters being pulled apart. The expansion would be strong enough to tear individual galaxies apart, followed by solar systems. In the final moments, planets would be ripped from their stars, followed by stars themselves. Eventually, the forces holding atoms together would be overcome, and even subatomic particles would be torn apart. The current Hubble constant defines a rate of acceleration of the universe not large enough to destroy local structures like galaxies, which are held together by gravity, but huge enough to increase the space between them. A steady increase in the Hubble constant to infinity would result in all material objects in the universe, starting with galaxies and eventually in a finite time all forms, no matter how small, decomposing into unbound elementary particles, radiation and beyond. As the energy density, scale factor and expansion rate become infinite, the universe ends as what is effectively a singularity. In the special case of phantom dark energy, which has supposed negative kinetic energy that would result in a higher rate of acceleration than other cosmological constants predict, a more sudden big rip could occur. The Big Rip is a theoretical possibility and not the most likely outcome, as it requires dark energy to behave in a specific way. Current data suggests dark energy is roughly constant, and a Big Rip is not predicted by this model. However, the exact nature of dark energy is still a mystery, and some experimental evidence has hinted at possibilities that would make this scenario more likely, according to Universe Today.

Big Crunch. The Big Crunch is another hypothetical scenario for the final destiny of the universe, in which the expansion of the universe eventually reverses and the universe re-collapses, ultimately triggering the cosmic scale factor to reach absolute zero. And this is an event potentially followed by a reformation of the universe starting with another Big Bang. The vast majority of current evidence indicates that, this hypothesis may not be correct. In its place, astronomical observations show that, the expansion of the universe is accelerating rather than being slowed by gravity, suggesting that a Big Chill or Big Rip is much more likely to occur.

' Nonetheless, some physicists have proposed that a "Big Crunch-style" event could result from a dark energy fluctuation. The Big Crunch hypothesis is a symmetrical view of the ultimate fate of the universe. This theory assumes that the average density of the universe will be enough to stop its expansion and the universe will begin contracting, just as the theorized Big Bang started as a cosmological expansion. We may imagine or a simple estimation would have all the matter and spacetime in the universe collapse into a dimensionless singularity back into how the universe started with the Big Bang, but at these scales unknown quantum effects need to be considered. Recent evidence suggests that this scenario is unlikely but has not been ruled out, as measurements have been available only over a relatively short period of time and could reverse in the future. Such scenario allows the Big Bang to occur immediately after the Big Crunch of a preceding universe. Again, if this happens repeatedly, it creates a cyclic model, which is also known as an oscillatory universe. The universe could then consist of an infinite sequence of finite universes, with each finite universe ending with a Big Crunch that is also the Big Bang of the next universe. A problem with the cyclic universe is that, it does not reconcile with the second law of thermodynamics, as entropy would build up from oscillation to oscillation and cause the eventual heat death of the universe. Current evidence also detects the universe is not closed rathe open ended. This has caused cosmologists to abandon the oscillating universe model. So, a similar idea is incorporated by the cyclic model, but this idea escapes heat death because of an expansion of the branes that dilutes entropy accumulated in the previous cycle.

Big Bounce. The Big Bounce may consider as another strong hypothesis and which is a cosmological model for the origin of the known universe. It was initially suggested as a phase of the cyclic model or oscillatory universe interpretation of the Big Bang, where the first cosmological event was the result of the collapse of a previous universe.' It retreated from serious consideration in the early 1980s, after inflation theory emerged as a solution to the horizon problem, which had arisen from advances in observations revealing the large-scale structure of the universe. The Big Bounce is a theorized scientific model related to the beginning of the known universe. According to one version of the Big Bang theory of cosmology, in the beginning of the universe was infinitely dense. This description seems to be at odds with other more widely accepted theories, especially QM and its uncertainty principle. Therefore, QM has given rise to an alternative version of the Big Bang theory, precisely that the universe tunneled into existence and had a finite density consistent with QM, before evolving in a manner governed by classical physics. In case, where the universe is closed, this theory would predict that once this universe collapses, it will spawn another universe in an event similar to the Big Bang after a universal singularity is reached or a repulsive quantum force causes re-expansion. This theory states that the universe will continuously repeat the cycle of a Big Bang, followed by a Big Crunch. So, here inflation was found to be inevitably eternal, creating an infinity of different universes with typically different properties, suggesting that the properties of the observable universe are a matter of chance. An alternative concept that included a Big Bounce was conceived as a predictive and confirmable possible solution to the horizon problem. Investigation continued as of 2022.'' We may get some new explanation or clarification of present concept.

Big Slurp. Big Slurp theory suggests that the universe currently exists in a false vacuum and that it could become a true vacuum at any moment. In order to best understanding, before discussion of the false vacuum collapse theory, one must first understand the Higgs field which permeates the universe. It almost similar to electromagnetic field, it varies in strength based upon its potential. A true vacuum exists so long as the universe exists in its lowest energy state, in which case the false vacuum theory is irrelevant. However, if the vacuum is not in its lowest energy state or a false vacuum, it could tunnel into a lower-energy state., This is called vacuum decay. This has the potential to fundamentally alter the universe: in some scenarios, even the various physical constants could have different values, severely affecting the foundations of matter, energy, and spacetime. It is also possible that all structures will be destroyed suddenly, without any forewarning. However, only a portion of the universe would be destroyed by the Big Slurp, while most of the universe would still be unaffected because galaxies located further than 4,200 megaparsecs or 13 billion light-years away from each other. Again, they are moving away from each other faster than the speed of light while the Big Slurp itself cannot expand faster than the speed of light. To place this in context, the size of the visible universe is currently about 46 billion light years in all directions from earth. The universe is thought to be that size or larger.

One of the newest reports released suggests something ominous as if the Higgs Boson truly exists at the appropriate mass, our universe may be in some serious trouble. At least it is according to a theoretical physicist from the Fermi National Accelerator Laboratory in Batavia, Illinois, who claims, 'If you use all the physics that we know now and you do what you think is a straightforward calculation, it's bad news.' Many physicists have been discussing the possibility of our universe teetering on the edge of stability for many years now. Especially physicists Michael Turner and Frank Wilczek, who published a paper in Nature back in 1982 and that suggested this unfriendly scenario as per their statement 'without warning, a bubble of true vacuum could nucleate somewhere in the universe and move outwards at the speed of light, and before we realized what swept by us our protons would decay away.' According to Lykken calculations (which hinge on the mass of the Higgs being correct, or off by a small margin of 1%), many tens of billions of years from now, the universe would experience some catastrophic event as a bubble formed from quantum fluctuations. That is from some sort of an alternate universe with a lower-energy state might appear in ours, expanding and ultimately destroying us at the speed of light, to boot, they said. Even more interestingly, these calculations brought up a question more philosophical than anything else, bringing him to ultimately wonder if the state of

our universe is instrumental in producing stars, galaxies, planets, matter and ultimately, life.

Cosmic uncertainty. It refers to the inherent limits on our ability to know the universe with perfect accuracy, stemming from two main sources: cosmic variance and fundamental physical principles. Cosmic variance is the statistical uncertainty that arises because we can only observe one universe, which is a single sample with random fluctuations. Fundamental principles, such as Heisenberg's uncertainty principle, place a universal limit on how precisely certain pairs of physical properties (like energy and time) can be known at the same time. Actually, Cosmologists can only ever study our one universe. Because of this, our observations of phenomena like the cosmic microwave background or large-scale galaxy distribution are limited to a single realization. The early universe had random quantum fluctuations that grew into the large-scale structures we see today. This means our observable patch is not necessarily a perfectly average representation of the entire universe. Cosmic variance introduces an unavoidable statistical uncertainty in measurements of cosmic properties, such as the density of matter or the characteristics of early universe fluctuations. For example, a region of sky surveyed might have a slightly higher or lower density of galaxies by chance. Each possibility as described in this paper so far is based on a simple form of the dark energy equation of state and the latest theories or hypotheses of physics. However, as the name implies, little is now known about the physics of dark energy or even black holes or vacuums in the universe.

On the other hand, if the theory of inflation is true, the universe went through an event dominated by a different form of dark energy in the first moments of the Big Bang; but inflation ended, indicating an equation of state more complex than those assumed for present-day dark energy. It is possible that the dark energy equation of state could change again, resulting in an event that would have consequences which are difficult to predict or parameterize. As the nature of dark energy and dark matter remain enigmatic, even hypothetical, the possibilities surrounding their role in the universe are unknown. As we investigate further into cosmology, bio-information theory, and the different models of consciousness, we will be able to further hypothesize and validate our last survival resort when the universe dies. A positive cosmological constant is a problem. An accelerating universe means that galaxies and galactic entities eventually “grow” apart. Energy stored in these areas would be inaccessible. Unless, of course, if you bring in the dark house—dark energy. No one really knows what dark energy is and what it does. So, this remains unresolved. The largest obstacle towards achieving Dyson’s eternal intelligence is to pass below the physical threshold necessary to the maintenance of conscious awareness. Granted that organic lifeforms are certainly inefficient in turning energy into computations (and consciousness), perhaps inorganic lifeforms or even alternative molecular structures might require much less energy to give rise to consciousness.

7. Conclusion

What we perceive as the force of gravity is actually objects (like planets or light) following the straightest possible path (a geodesic) through this curved spacetime. Planets orbit stars because they are following the curves in spacetime created by the star's mass, not because of a direct pull. Again, Light from distant stars bends as it passes massive objects, confirming the curvature of spacetime. The famous summary ‘matter tells spacetime how to curve, spacetime tells matter how to move**,’** captures the dynamic interaction, where mass dictates the geometry, and the geometry dictates motion. According to scientists, the expansion of the universe began with the Big Bang. This expansion was completely uniform everywhere. Matter was distributed equally everywhere. Then stars, planets and galaxies came into existence in the universe from them. NASA scientists were shocked when in 1981, Sir Robert Kirchner discovered a void in the constellation of Boötes, 800 million light years away from Earth, which was completely uninhabited. It was given this name because of this "constellation". If we calculate the expansion of the universe since the Big Bang and then. So, based on the expansion that has occurred so far, there should be at least ten to twelve thousand galaxies in this empty space, but there is nothing like that there. Although there are other empty spaces in the universe, such a vast area and that too completely empty is beyond "understanding".

As we know that, when physicists tried to combine quantum mechanics and general relativity, their equations resulted in infinities and anomalies. String theory avoids these issues but only if the universe has a specific number of dimensions. M-theory, an 11-dimensional theory involving membranes (p-branes) as well as strings, emerged in the mid-1990s as a powerful candidate for the unified theory. We experience only four dimensions, where three spatial and one temporal. The extra seven dimensions are theorized to be compactified or curled up into a space so tiny that they are not observable with current technology, perhaps having an effect only at incredibly small scales or in extreme conditions like within black holes. The God Equation itself has not been finalized or experimentally proven. The term ‘God Equation’ or ‘Theory of Everything’ is a conceptual name for a single, elegant mathematical formula, perhaps no more than one inch long, that would summarize all the rules of the universe. Kaku posits that the ability of string theory to automatically include gravity in its quantum calculations makes it the most promising avenue for discovering this ‘God Equation’ or ToE. So far, the finding it would allow humanity to potentially answer some of the deepest questions in science, from the moment before the Big Bang to the possibility of time travel.

Micho Kaku said, “First, there is the personal God, the God that you pray to, the God of the Bible who smites the Philistines and rewards the believers. He did not believe in that God. He did not believe that the God who created the universe interfered in the affairs of mere mortals. However, he believed in the God of Spinoza—that is, the God of order in a universe that is beautiful, simple, and elegant. The universe could have been ugly, random, chaotic, but instead it has a hidden order that is mysterious yet profound.” He also said,

"mathematician's patterns, like the painter's or the poet's, must be beautiful; the ideas, like the colours or the words, must fit together in a harmonious way. Beauty is the first test; there is no permanent place in the world for ugly mathematics. And that beauty is symmetry." About string and M theory Kaku said, "If we had a microscope powerful enough, we could see that electrons, quarks, neutrinos, etc. are nothing but vibrations on minuscule loops resembling rubber bands. If we pluck the rubber band enough times and in different ways, we eventually create all the known subatomic particles in the universe. This means that all the laws of physics can be reduced to the harmonies of these strings. Chemistry is the melodies one can play on them. The universe is a symphony. And the mind of God, which Einstein eloquently wrote about, is cosmic music resonating throughout space-time." About difference between string and M theory Kaku said, "So string theory and M-theory are really the same theory, except that string theory is a reduction of eleven-dimensional M-theory to ten dimensions." Kaku also added, "Unfortunately, with the collapse of classical civilization, these philosophical discussions and debates were lost. The concept that there could be a paradigm explaining the universe was forgotten for almost a thousand years. Darkness spread over the Western world, and scientific inquiry was largely replaced by belief in superstition, magic, and sorcery."

The universe is often viewed by some scientists as an intricate tapestry, with every individual element like stars, galaxies, life forms and are representing a thread. Understanding the cosmos is like appreciating the immense and complex pattern of the whole, recognizing how all the threads interweave to form a masterpiece. Historically from Aristotle to Copernicus, the universe was metaphorically an onion, with the Earth at the centre, surrounded by concentric, crystalline spheres. Understanding the cosmos was peeling back these layers. This contrasts with modern understanding, but highlights how metaphors evolve with knowledge. Metaphors for cosmic understanding often compare the vast and abstract nature of the universe to more familiar, tangible human experiences or objects. These comparisons help to conceptualize complex scientific and philosophical ideas. So, this discussion emphasizes a profound truth that the cosmos is far more intricate and mysterious than once believed. By addressing open questions about dark matter, magnetic fields, time, neutrinos, inflation, and even the possibility of a simulated reality, this collection illustrates how modern astrophysics and cosmology are increasingly interwoven with cutting-edge physics, speculative ideas, and technological innovation. Ultimately, the evaluation suggests that the astonishing nature of the universe is inseparably linked to its uncertainties. Each new discovery provides answers to old questions while simultaneously paving the way for deeper, more challenging mysteries, embodying the dynamic nature of scientific exploration. The analysis and the findings of the latest physics is not only challenging existing paradigms but also offer hints into deeper layers of physical law, potentially reshaping our understanding of existence itself and uncertainty of universe. As our future observation will improves and theory of physics advances, the answers to these questions may unlock entirely new dimensions both factually and symbolically of cosmic consideration.

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FREE ENERGY OF NONREGULAR CONDENSED SYSTEMS WITH IMPURITIES

Marsagishvili T.,
Doctor of phys.-mat. sciences, head of Department of Fundamental Research and Composite Materials Synthesis, R. Agladze Institute of Inorganic Chemistry and Electrochemistry (IICE) of Iv. Javakhishvili Tbilisi State University (TSU), Tbilisi.
Machavariani M.
Candidate of phys.-mat. sciences, senior researcher, Department of Fundamental Research and Composite Materials Synthesis, IICE, TSU, Tbilisi.
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Abstract
In the study of nonregular condensed systems with impurity particles, one of the necessary and complex problems is the calculation of the characteristics of the system itself, and, first and foremost, the free energy of the system [1-8]. The aim of this work is precisely the theoretical calculation of the thermodynamic characteristics of complex nonregular condensed systems with polyatomic impurity particles, taking into account the intramolecular vibrations of the impurities. Temperature-dependent Green's functions are a convenient tool for calculating the thermodynamic characteristics of such systems. Theoretical calculations using temperature-dependent Green's functions allow for consideration of both the effects of frequency and spatial dispersion in condensed systems, as well as the specific interactions between polyatomic impurity particles and the medium.

Keywords: free energy, Green functions, condensed medium, nonregular systems, impurity particles

Free energy of the system

The electrostatic part of the change in the free energy of the system upon introduction of a polyatomic polarizable particle into a condensed medium can be represented as:

$$\delta\Omega = \delta\Omega_0 + \delta F^m + \delta\Omega_1 + \delta\Omega_2 \quad (1)$$

where $\delta\Omega_0$ is the free energy of solvation calculated at the equilibrium values of the intramolecular coordinates of the impurity vibrations, δF^m is the solvation energy of the medium caused by a charged impurity particle, $\delta\Omega_1$ is the change in the free energy of the system caused by the interaction of the polarization fluctuations of the medium with the static field of the impurity, $\delta\Omega_2$ is the change in the free energy of the system associated with the interaction of the polarization fluctuations of the medium with the intramolecular vibrations of the impurity.

When polyatomic charged impurity particles dissolve in a condensed medium, the main contribution to the change in the free energy of the system will be made by $\delta\Omega_1$.

To calculate the value of $\delta\Omega_1$, one can use the relationship between the change in free energy and the corresponding *S*-matrix, which has the form

$\delta\Omega_1 = -kTln\langle S_{(1)}\rangle_0$ (2)

And $S_{(1)}$ matrix has the form:

$$S_{(1)}(\beta) = T_\tau exp\left[\int_0^\beta d\tau \int d\vec{r}\delta\vec{P}(\vec{r},\tau)\Delta\vec{E}(\vec{r})\right] \ \beta = 1/kT \quad (3)$$

In the last formula, $\delta\vec{P}$ is the polarization fluctuation of the system, and $\Delta\vec{E}$ is the change in the electric field strength of the reactants during the charge transfer process, *T* – temperature.

If the exponential function in the *S*-matrix is represented as a series, then

$$\langle S_{(1)}\rangle_0 = \sum_{n=0}^{\infty}\frac{1}{(2n)!}\int d\overrightarrow{r_1}\ldots\int d\overrightarrow{r_{2n}}\int_0^\beta d\tau_1\ldots\int_0^\beta d\tau_{2n}E^0_{i_1}(\overrightarrow{r_1})\ldots E^0_{i_{2n}}(\overrightarrow{r_{2n}})\cdot\langle T_\tau\delta P_{i_1}(\vec{r}_1\tau_1)\ldots\delta P_{i_{2n}}(\overrightarrow{r_{2n}},\tau_{2n})\rangle_0 \quad (4)$$

Here, quantum-statistical averaging is performed over the states of the Hamiltonian of the medium H^m.

In the approximation of decoupling of quantum-statistical averages for operators $\delta\vec{P}$, we obtain

$$\langle S_{(1)}\rangle_0 = exp\left[-\frac{1}{2}\int d\vec{r}d\overrightarrow{r'}\int_0^\beta d\tau\int_0^\beta d\tau' E^0_i(\vec{r})E^0_k\left(\overrightarrow{r'}\right)G^0_{\delta P_i\delta P_k}(\vec{r},\vec{r}';\tau-\tau')\right] \quad (5)$$

Passing to the Fourier representation in imaginary time and integrating over τ and τ', we obtain:

$$\langle S_{(1)}\rangle_0 = exp\left[-\frac{1}{2}\int d\vec{r}d\overrightarrow{r'}E^0_i(\vec{r})E^0_k\left(\overrightarrow{r'}\right)G^0_{\delta P_i\delta P_k}(\vec{r},\vec{r}';\ \omega=0)\right] \quad (6)$$

Since at $\omega = 0$, $G(\omega_n = 0) = G^R(\omega = 0)$, then

$$\delta\Omega_1 = \frac{1}{2}\int d\vec{r}d\overrightarrow{r'}E^0_i(\vec{r})E^0_k\left(\overrightarrow{r'}\right)G^0_{\delta P\delta P}(\vec{r},\vec{r}';\ \omega=0) \quad (7)$$

For the change of the free energy of a system when charged particles are introduced into a condensed medium, the following form of writing can be used:

$$\delta\Omega_1 = \frac{1}{2}\int d\vec{r}d\overrightarrow{r'}G_{\rho\rho}(\vec{r},\vec{r}')\varphi^{ex}(\vec{r},)\,\varphi^{ex}\left(\overrightarrow{r'},\right)\frac{1}{2}G_{\varphi\varphi}\rho^{ex}\rho^{ex} \quad (8)$$

where φ^{ex} and ρ^{ex} are the scalar potential and charge density of the impurity particle, respectively

When determining the Green function $G_{\varphi\varphi}(\vec{r},\vec{r}')$, it can be taken into account that, with an accuracy of up to the electron charge, the Green function $G_{\varphi\varphi}(\vec{r},\vec{r}')$ coincides with the magnitude of the electrostatic potential of the system at the point $\vec{r}$ when a unit charge is placed at the point $\vec{r}'$.

Effects of spatial dispersion of the medium

The effects of spatial dispersion of the medium when calculating the change in the free energy of the system upon the introduction of impurity particles into a condensed medium can be taken into account if some model functions are used as the Green function operators of the polarization fluctuations of the medium, or the charge density, or the scalar potential of the medium. In this case, for Green function can be used a function of the type:

$$G_{\varphi\varphi}(\vec{r},\vec{r}') = f(\vec{r})\frac{1}{|\vec{r}-\vec{r}'|} \quad (9)$$

where $f(\vec{r})$ is some function of the coordinate r.

In this case, the behavior of the Green function will be of the type:

$$G_{\varphi\varphi}(\vec{r},\vec{r}') = G_{\rho\varphi}(\vec{r},\vec{r}') = -f(\vec{r})\delta(\vec{r}-\vec{r}') \quad (10)$$

The Fourier component of the function $f(\vec{r})$ can be expressed through the longitudinal component of the dielectric constant of the medium $\varepsilon^l(k)$:

$$f(\vec{k}) = [1 - 1/\varepsilon^l(k)]\,{}^1\!/_{4\pi} \quad (11)$$

As a result for Green function we have:

$$G_{\varphi\varphi}(\vec{k},\vec{k}') = -{}^1\!/_{4\pi}\left[1 - {}^1\!/_{\varepsilon^l(k)}\right]\delta_{\vec{k}\vec{k}'} \quad (12)$$

For homogeneous isotropic local media we have

$$G_{\varphi\varphi}(\vec{k},\vec{k}') = -{}^1\!/_{4\pi}\left[1 - {}^1\!/_{\varepsilon^l(k)}\right]\delta_{\vec{k}\vec{k}'} \equiv -\left({}^{C_0}\!/_{4\pi}\right)\delta_{\vec{k}\vec{k}'} \quad (13)$$

Accordingly, in $\vec{r}$-space the Green function has the form:

$$G_{\varphi\varphi}(\vec{r},\vec{r}') = -\left({}^{C_0}\!/_{4\pi}\right)\delta(\vec{r}-\vec{r}') \quad (14)$$

If the impurity particle is a spherically symmetric particle of radius r_0 and has a charge z, then for the change in free energy we obtain

$$\delta\Omega_1 = -{}^{C_0 z^2}\!/_{8\pi r_0} = -\left({}^{z^2}\!/_{8\pi r_0}\right)\left(1 - {}^1\!/_{\varepsilon}\right) \quad (15)$$

To take into account the effects of spatial dispersion of the medium, the function $G_{\varphi\varphi}$ in formula (14) is "blurred." We introduce the function

$$G_{\varphi\rho}(\vec{r},\vec{r}') = -\left({}^{C_0}\!/_{4\pi}\right)\Delta_\lambda(|\vec{r}-\vec{r}'|) \quad (16)$$

where, as function, we choose an exponentially decaying function normalized to unity of the form

$$\Delta_\lambda(|\vec{r}-\vec{r}'|) = \left({}^1\!/_{8\pi\lambda^3}\right)exp\left({}^{|\vec{r}-\vec{r}'|}\!/_{\lambda}\right) \quad (17)$$

If we use the classical approximation for ρ^{ex} and assume that the charge localization point coincides with the origin of the coordinate system, then

$$\rho^{ex}(\vec{r}) = z\delta(\vec{r}) \quad (18)$$

where z is the charge of the impurity particle.

In this case, for $\delta\Omega_1$ we have:

$$\delta\Omega_1 = -{}^{C_0 z^2}\!/_{16\pi\lambda} = \left(-{}^{C_0 z^2}\!/_{16\pi\lambda}\right)\left(1 - {}^1\!/_{\varepsilon}\right) \quad (19)$$

Similarly, one can calculate the change in the free energy of a system in which the spatial dispersion effect has a complex form. For example, for a system with oscillations and damping, the function Δ_λ can be calculated as:

$$\Delta_{\bar{\lambda}}(|\vec{r}-\vec{r}'|) = \left[{}^{\nu\left(\nu^2 - 3\bar{\lambda}^2\right)}\!/_{8\pi}\right]e^{-\nu|\vec{r}-\vec{r}'|}cos\left(\bar{\lambda}|\vec{r}-\vec{r}'|\right) \quad (20)$$

In this case, for the change of the system's free energy, we obtain:

$$\delta\Omega_1 = -\left({}^{C_0}\!/_{8\pi}\right)\left[{}^{\nu\left(\nu^2 - 3\bar{\lambda}^2\right)}\!/_{\left(\left(\nu^2 - \bar{\lambda}^2\right)^2 - 4\bar{\lambda}^2\nu^2\right)}\right] \quad (21)$$

The parameter $1 / \bar{\lambda}$ will be approximately equal to the diameter of the solvent molecule.

For the quantum approximation, the charge density ρ^{ex} can be expressed as follows:

$\rho^{ex}(\vec{r}) = e|\Psi(\vec{r})|^2$ (22)

Here $\Psi(\vec{r})$ is the wave function.

The normalized function can be used as the wave function:

$$\Psi(\vec{r}) = \left[{}^{\alpha^{3/2}}\!/_{(8\pi)^{1/2}}\right]e^{-\alpha r/2} \quad (23)$$

For this case, for the change in the free energy of the system $\delta\Omega_1$, we obtain:

$$\delta\Omega_1 = -\left({}^{C_0 e^2}\!/_{32\pi^2}\right)\int d\vec{r}d\vec{r'}\,d\vec{r''}\Delta_\lambda(|\vec{r}-\vec{r}'|)\left[{}^{|\Psi(\vec{r})|^2\left|\Psi\left(\vec{r''}\right)\right|^2}\!/_{|\vec{r}-\vec{r}''|}\right] \quad (24)$$

Considering the form of the function $\Delta_\lambda(|\vec{r}-\vec{r}'|)$ (17) and taking the wave function as shown in (23), we have

$$\delta\Omega_1 = -\left({}^{C_0 e^2\alpha^6}\!/_{(8\pi)^4\lambda^3}\right)\int d\vec{r}d\vec{r'}\,d\vec{r''}exp\left(-\frac{|\vec{r}-\vec{r}'|}{\lambda}\right)\exp\left[-\alpha(r+r'')\frac{1}{|\vec{r}'-\vec{r}''|}\right] \quad (25)$$

After integrating over coordinates $\vec{r}$, $\vec{r'}$, and $\vec{r''}$, we obtain

$$\delta\Omega_1 = -\left(C_0 e^2 (\alpha/2)^4 / 8\pi\lambda^2\right)\left(32\alpha^7 - 4\alpha^9\lambda^2 + 4\alpha^6/\lambda - 55\alpha^5/\lambda^2 - 21\alpha^4/\lambda^3 + 38\alpha^3/\lambda^4 + 26\alpha^2/\lambda^5 - 20\alpha/\lambda^6 - 12/\lambda^7\right) \quad (26)$$

If we use a function $\Delta_\lambda(|\vec{r} - \vec{r}'|)$ in the form (20), then for $\delta\Omega_1$ we obtain:

$$\delta\Omega_1 = -\left[C_0 e^2 (\alpha/2)^4 \nu(\nu^2 - 3\bar{\lambda}^2)/8\pi\right] Re\left\{32\alpha^7\left[1/(\nu - i\bar{\lambda})\right] - 4\alpha^9/(\nu - i\bar{\lambda})^3 + 4\alpha^6 - 55\alpha^5(\nu - i\bar{\lambda}) - 21\alpha^4(\nu - i\bar{\lambda})^2 + 38\alpha^3(\nu - i\bar{\lambda})^3 + 26\alpha^2(\nu - i\bar{\lambda})^4 - 20\alpha(\nu - i\bar{\lambda})^5 - 12(\nu - i\bar{\lambda})^6\right\} \quad (27)$$

To describe the effects of spatial dispersion of the medium, we can also use a function of the form

$$\Delta_\lambda(|\vec{r} - \vec{r}'|) = \left(1/\lambda^3\lambda^{-3/2}\right) exp\left(-|\vec{r} - \vec{r}'|^2/\lambda^2\right) \quad (28)$$

In this case, if for the wave function we use the form (23), then for $\delta\Omega_1$we obtain:

$$\delta\Omega_1 = -C_0 e^2\alpha^3/4 \int_0^\infty dr r e^{-\alpha r}\Phi\left(r/\lambda\right) \quad (29)$$

where $\Phi\left(r/\lambda\right)$ is the error integral

$$\Phi\left(r/\lambda\right) = 1/\sqrt{\pi}\int_0^{r/\lambda} e^{-t^2}dt \quad (30)$$

During numerical calculations, for the error integral, we can use the following approximation:

$$\Phi\left(r/\lambda\right) = 1 - \sqrt{\frac{2}{\pi}}e^{-(r/\lambda)^2}[b_1 t + b_2 t^2 + b_3 t^3 + b_4 t^4 + b_5 t^5] \quad (31)$$

where

$t = 1/\left(1 + P\sqrt{2}\frac{r}{\lambda}\right)$; P=0.2316; $b_1 = 0.3195$; $b_2 = -0.3566$; $b_3 = 1.7815$; $b_4 = -1.8213$; $b_5 = 1.3303$ (32)

For the charge density in the quantum case, one can also use expression

$$\rho(\vec{r}) = \left(e\alpha^3/56\pi\right)\left(1 + \alpha r/2\right)^2 e^{-\alpha r} \quad (33)$$

If we use expression (28) for function Δ_λ, then for $\delta\Omega_1$ we have:

$$\delta\Omega_1 = -\left(9C_0 e^2\alpha/56\right) + \left(C_0 e^2\alpha^3/14\sqrt{2\pi}\right)\int_0^\infty dr\left\{r\left(1 + \frac{\alpha r}{2}\right)^2[b_1 t + b_2 t^2 + b_3 t^3 + b_4 t^4 + b_5 t^5]e^{-\left(\alpha r + r^2/\lambda^2\right)}\right\} \quad (34)$$

For the change of the free energy of a system when a polyatomic polarizable dipole charged particle is introduced into a condensed medium, calculations can be carried out with one or another degree of accuracy, taking into account various effects: the quantum or classical nature of the impurity characteristics, the effects of spatial dispersion of the medium, which can be described by various model functions; the interaction of intramolecular vibrations of the impurity with polarization fluctuations of the medium.

Conclusion

Charge transfer processes in complex condensed systems were studied. Free energies of solvation were calculated for the complex nonregular condensed systems with polyatomic impurity particles. To calculate the free energies of solvation of particles in condensed systems, the apparatus of temperature Green functions for nonregular condensed systems was used, allowing for the effects of frequency and spatial dispersion of the system and the specific interactions of impurity particles with the medium to be taken into account. The characteristics of the system were obtained taking into account the electrostatic interaction of the impurity particle with the medium. In particular, the theoretical results obtained allow us to calculate the solvation energies of impurity particles in nonregular condensed medium, in which spatial dispersion effects are described by various functions.

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PSYCHOLOGICAL SCIENCES

AGGRESSIVE BEHAVIOR IN CHILDREN AND ADOLESCENTS PSYCHOSOCIAL FUNDAMENTALS

Salamova A.
Senior lecturer of the Sheki branch of Azerbaijan State Pedagogical University
https://doi.org/10.5281/zenodo.18070647

Abstract

The article examines the causes and socio-psychological sources of aggressive behavior observed in childhood and adolescence. The main factors affecting the formation of aggression, such as family relationships, unmet emotional needs, communication problems, and the influence of the media and digital environment, are analyzed. The changes in behavioral reactions during the transition from childhood to adolescence and the risk factors of these changes are highlighted. The article presents practical preventive approaches for parents to manage and prevent aggressive behavior, and emphasizes the importance of redirecting aggression to constructive forms of behavior.

Keywords: aggression, destructive behavior, psychological discomfort, conflict, physical force, constructive solution

Introduction

Aggression is an integral part of human social life. “Aggression (from Latin "aggredi" - to attack) is a motivated destructive behavior that contradicts the norms and rules that ensure the existence and coexistence of people in society. It is based on attacking animate and inanimate objects, causing physical and moral harm to people, and causing psychological discomfort in them” [1, p. 243]. Aggression mainly occurs as a reaction of the subject to frustration and is accompanied by emotional states such as resentment, anger, hostility, and hatred. An aggressive person can lose everything he has gained in life through his behavior.

Aggression is not only a means of self-defense or protection of the needs of the individual, but also a form of destructive behavior that can have negative consequences in social interactions. There are various types of it: physical, indirect, irritating, verbal and negativism. In addition, aggression is also divided into hostile and instrumental forms. The purpose of hostile aggression is to harm the other party, while instrumental aggression is used as a means to achieve a certain goal.

Aggression can also manifest itself as a self-protection, emotional release, or defense mechanism in a person. Child aggression can be identified both in a collective setting and during individual observations.

A child's attitude to the world begins to form during the mother's pregnancy. The mother's psychological state and emotional tension directly affect the child's future emotional development. For example, the mother's state of stress, fear, and anxiety creates a sense of danger and unpredictability in the child's early experiences.

Studies show that aggressive behavior is more common in boys than in girls. During group play and interactions, children exhibit different behavioral patterns, and unfortunately, these behaviors are destructive rather than positive.

Aggressive behaviors are considered a behavioral disorder in psychology. Aggressive behaviors include: shouting loudly, using abusive language, crying for no reason, physically harming others, harming oneself, "attacking" sometimes with action, sometimes with words, inability to adopt ethical norms, not obeying "social laws", often being tense and irritable, having difficulty communicating with others, always being ready for conflict, not solving problems constructively, always relying on physical strengthetc.

If a child repeats his behavior regardless of time, place, or the people around him, then aggressive behavior can be considered a psychological behavioral disorder. For example, if a child behaves in accordance with all ethical and social norms in kindergarten, but responds to demands made on him at home by shouting, biting, or other aggressive methods, this is only considered aggressive behavior. However, if a child shows the same destructive reactions both at home and in kindergarten, this is already a sign of a systemic psychological behavioral disorder, and in such cases, the intervention of a professional psychologist or psychiatrist is definitely required.

Before children develop speech, they communicate their natural needs to their parents mainly through crying. During this period, crying becomes their main means of communication. Over time, children's emotional expression gradually takes a back seat, and as they grow older, they begin to express their thoughts through speech. It is crucial for parents to understand their children correctly and support their speech development. Otherwise, a child who is not understood correctly or does not receive an adequate response from their parents may show aggressive reactions. In this case, the child tends to express his dissatisfaction by harming those around him. For example, if a one-year-old child cannot throw an object on the table, a 4-5-year-old child can already do this with ease and at the same time may demonstrate other unpleasant, destructive behaviors.

Aggression in children can be caused not only by psychosocial factors, but also by organic causes. For example, inflammatory processes in the central nervous system or other neurobiological disorders can influence the emergence of aggressive behavior. In such cases, medical treatment and appropriate therapeutic intervention are required for proper management of behavior and symptom relief.

A child's inability to adequately release pent-up physical and emotional energy can also lead to aggressive behavior. To prevent this situation, it is recommended that the child regularly spend time outdoors, engage in physical activities such as sports and swimming, and allow him to release his energy through constructive play with peers.

One of the main reasons for the formation of aggressive behavior in children is the aggressive examples they observe. These examples can be the child's parents, relatives, close circle, social environment or television characters. The television and other media programs that children watch should be carefully monitored. As much as possible, it should be ensured that children are not exposed to aggressive scenes, and if they accidentally come across such scenes, those scenes should be explained by a parent or teacher and it should be emphasized that they are not true.

The lack of love, insufficient attention to the child, a tense atmosphere at home, conflicts between parents, as well as various family problems have a great psychological impact on children, creating deep trauma in them. Most children who have suffered such traumas exhibit aggressive behavior. Since children have weak psychological defenses, they are helpless and psychologically helpless against any shock. Psychological trauma inflicted in childhood can harm the child's future life, future development, and limit his development as a person. Taking all this into account, parents should try to keep their children away from family problems.

The modern era is full of both opportunities and challenges. New technologies provide children with the opportunity to obtain useful information, expand their knowledge and develop their creative abilities. At the same time, these technologies and their products can lead to the formation and strengthening of aggressive behavior in children. Computer games and online games in particular encourage aggressive reactions in children. School-age children are more sensitive to these influences and are prone to psychological damage. Children are sometimes even ready to resort to uncensored methods in games to defeat their opponents. This situation shows that there are numerous factors that negatively affect the psyche of children and it is not easy to prevent them. Therefore, every parent should be aware and take timely preventive measures so that children are not affected by such harmful games.

Almost at all ages, parents complain about their children's aggression. Unfortunately, parents often do not know that they are the cause of this aggression. In fact, instead of preventing aggression in children, they make them even more aggressive with their own reactions [3, p.16].

It is important to remember that each child is a mirror of his or her family. The difficulties a child experiences often stem from the family. Children reflect their experiences in the family in their behavior and demonstrate this at school, in their peer group, and in other social groups. If the school environment is friendly and supportive, and aggressive behavior is only rarely seen in one or two children, the problem is mainly related to the family environment.

Parents should understand that any factor that prevents aggressive children from expressing their feelings can negatively affect their emotional and physiological state, and as a result, the risk of developing nervous system disorders and somatic diseases increases. For this reason, it is important to teach children to express their aggressive feelings in an appropriate and constructive way. Parents should not expect that the child's aggression will not affect our internal dissatisfaction. On the contrary, they should monitor their own behavior and the behavior of the child, and communicate with them in a calm and polite manner. It is possible to raise the tone of voice when evaluating the child's behavior, but this should be done without touching the child's personality. The parent should only criticize the child's behavior, not interfere with his or her self. This approach allows aggressive behavior to be directed into a constructive and socially acceptable form.

One of the typical manifestations of deviant and destructive behavior, which also manifests itself in adolescence, is aggression. It is noteworthy that the intensity of aggressive behavior in adolescents is at a different pace and occurs at different ages in boys and girls. It has been established that the peak of aggression in adolescent boys occurs at the ages of 12 and 14-15, and in girls at the ages of 11-13.

Aggression occurs in adolescents for the following reasons: when they are unable to adequately express their thoughts and feelings verbally; when they think that the other party is being aggressive or aggressive towards them; when under psychological pressure; when feeling personal inadequacy, failure; when disappointed, etc.

Adolescence is characterized as a complex and emotionally stressful period for adolescents. During this period, adolescents are more prone to aggressive behavior, try to defend their rights, and sometimes demonstrate a protesting attitude towards their parents because they do not yet fully understand their personal desires. During this age period, harmful behaviors such as running away from home, risk of suicide, drug and alcohol use, and early initiation of sexual activity can also be observed, which results in regret for both the adolescent and his family. With these behaviors, the adolescent sends a message to those around him: “I can live without you.” At the same time, coming home late, spending a long time with friends, staying alone, and trying to prove their different opinions from their parents are also considered typical behavioral patterns of this period. In such circumstances, restricting the teenager's freedom, trying to control him by force, or dictating to him increases tension and leads to a deepening of behavioral problems.

There is a significant interaction between adolescents' self-esteem and aggressive reactions. Thus, adolescents with high levels of self-esteem also have a high level of aggressive reactions. This interaction is manifested in both instrumental and other types of aggression - especially in hostility and hostility behaviors. Thus, adolescents with high self-esteem also have a high level of physical aggression. At the same time, a relationship has been established between the aggression of adolescents prone to leadership and the assessment of their physical "I". Adolescent girls tend to evaluate themselves as more positive, socially desirable, kind, affectionate, caring and sensitive. Adolescent boys, on the other hand, consider themselves less active and more hostile than girls.

The types of aggression displayed by adolescents at school are divided into four main categories by Moeller:

Low level aggression – this category includes using bad language, pushing other students, being rude, and writing negative wall posts;

Aggression against real property (vandalism) – covers cases such as damaging school property and starting fires;

Dangers – this category includes a teenager openly threatening other students;

Physical aggression – fighting, violence, mockery, carrying and using weapons, as well as threats against teachers and other students are assessed in this group.

Providing children with love and attention from a young age, and growing up in a warm and supportive environment, can reduce the level of aggressive behavior during adolescence and help them become calmer and more regulated.

Prevention of aggression. Aggression is very difficult to deal with. If aggression continues for a long time, it becomes stronger and more difficult to prevent it. Also, if you try to hide and suppress aggression internally, it can manifest itself in a stronger and more harmful form the next time. Although aggression is difficult to control, it is possible to prevent it. Therefore, it is better to take preventive measures in advance. First of all, it is important to identify the factors that cause aggression. If necessary, the parent can use the support of a specialist in this matter.

Parents should never suppress aggression in children, because this feeling is natural in humans. Otherwise, suppressing aggression can lead to autoaggression (injury to oneself physically and morally) or psychosomatic problems in the child. Parents should teach their children not to suppress their aggression, but to control it.

If the aggression in children is not dangerous and understandable, ignoring the child's reaction is one of the effective ways to prevent unpleasant behavior. However, there are other effective ways: redirecting the child's attention elsewhere, offering him a different activity, saying words that show that we understand the child (for example, "it affects you, I understand you"), as well as interpreting the child's behavior in a positive way (for example, "you are angry because you are tired"), etc.

When you encounter aggressive behavior in children, criticize the child's actions, not his personality. For example, instead of saying, "You are a very bad child," it is more appropriate to use phrases like, "You are a very smart child, but this action you did is wrong, it does not suit you." It is necessary to describe how the child behaved, the words he said, and the actions he performed during aggression. It is important to pay attention to analyzing only the behavior that occurred "here and now," and not remembering past actions. Otherwise, the child may feel bitter feelings and be unable to criticize his own behavior. The most important thing is to discuss the child's behavior after he has calmed down, not during the aggression. This discussion should be held alone and in a calm situation. The child should be explained that the harm caused by aggressive behavior is more to him than to those around him. Children's negative actions should never be discussed in front of others so as not to embarrass them.

In addition, the child should be offered alternative activities where he can release his energy - for example, sports, music or other favorite hobbies. You can focus his attention on the positive through the art form or activity that your child is interested in. An atmosphere of peace should be ensured within the family, and violence should not be allowed under any circumstances. It is not right to respond to aggression with aggression. On the contrary, calm and constructive conversations should be held with children, and physical force should not be used. The child should not get what he wants through aggressive behavior, and the parent should demonstrate a firm and principled position on this issue.

In addition to all this, parents can apply a number of tips to help their children go through this stage relatively comfortably during adolescence. Even if you have a different opinion, listen carefully to your child and do not attribute their wrong behavior to their personality. Discuss their actions that you consider wrong together, evaluate them and set an example. Appreciate their positive behavior, be interested in what they do and pay attention to them. Do not hurt the child by fighting or applying harsh punishment; on the contrary, try to reach an agreement and find common solutions. Pressuring the child to fulfill your demands can lead to new aggression and conflicts. Do not try to completely subordinate the child to you. Create opportunities for them to fulfill your demands by understanding them and of their own will. Pay attention to your child's mental, emotional and social development and be open to criticism. This is your child in front of you - talk to them and listen to them with this in mind, not forgetting that they are your most valuable asset. Remember that this is a stage when they are going through hormonal changes.

“At the same time, demonstrating the ability to be restrained, patient, to constructively resolve challenges and conflicts, and to keep oneself within the framework of moral norms has no less impact on people than demonstrating aggressive behavior. A powerful tool that causes aggression is the presence of stimuli that are incompatible with violence. Kindness, compassion, humor, interest in joint cooperation, apology, etc. such

actions significantly weaken aggressive tendencies" [2, p.264]. To get rid of aggression, it is advisable not to react immediately to stress and to stay away from negative thoughts.

As a result, it can be noted that aggressive behavior in children and adolescents is not random and is mainly formed as a result of the interaction of numerous psychosocial factors. Family environment, parent-child relationships, level of emotional security, as well as social and digital influences directly affect the intensity of these behaviors. Aggressive reactions observed at an early age, if not managed with the right approach in a timely manner, can develop into more complex and risky forms of behavior during adolescence. In this regard, understanding the causes of aggression and directing it constructively, rather than punishing it, should be considered a more effective approach. The joint activities of parents, teachers and specialists create conditions for the formation of a child's emotional regulation skills, resolving conflicts in non-violent ways, and developing healthy social behaviors. The consistent and systematic application of preventive measures can significantly contribute to the reduction of behavioral disorders in the future and the formation of a psychologically healthy generation.

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SOCIAL SCIENCES

IT COMMUNITIES AS A FORM OF SOCIAL ORGANISATION IN CYBERSPACE

Dushmanov D.
LLM, MA (Politics and Security),
PhD candidate at L. N. Gumilyov Eurasian National University, Kazakhstan

ИТ-СООБЩЕСТВА КАК ФОРМА СОЦИАЛЬНОЙ ОРГАНИЗАЦИИ В КИБЕРПРОСТРАНСТВЕ

Душманов Д.
Магистр в области политики и безопасности, Магистр права,
Докторант программы PhD ЕНУ им Л. Н. Гумилева, Казахстан
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Abstract

This article provides a theoretical analysis of IT communities as a form of social organisation in cyberspace. It examines the mechanisms of coordination, self-regulation, and stratification within professional digital communities, as well as the influence of platform conditions and the accelerated dynamics of digital labour on their functioning. The study demonstrates that IT communities represent hybrid forms of social organisation that combine network-based interaction, informal mechanisms of order, and infrastructural constraints imposed by the digital environment. The findings offer a theoretical basis for further research into digital forms of collective action.

Аннотация

Статья посвящена теоретическому анализу ИТ-сообществ как формы социальной организации в киберпространстве. Рассматриваются особенности координации, саморегуляции и стратификации в профессиональных цифровых сообществах, а также влияние платформенных условий и ускоренной динамики цифрового труда на их функционирование. Показано, что ИТ-сообщества представляют собой гибридные формы социальной организации, сочетающие сетевую логику взаимодействий, неформальные механизмы порядка и инфраструктурные ограничения цифровой среды. Полученные выводы формируют теоретическую основу для дальнейших исследований цифровых форм коллективного действия.

Keywords: IT communities, social organisation, cyberspace, digital communities, reputation, self-regulation, digital platforms.

Ключевые слова: ИТ-сообщества, социальная организация, киберпространство, цифровые сообщества, репутация, саморегуляция, цифровые платформы.

Введение

Цифровизация социальных процессов и расширение киберпространства привели к возникновению новых форм социальной организации, в рамках которых традиционные институциональные механизмы координации и контроля утрачивают доминирующее значение. Одной из наиболее показательных форм такой трансформации выступают ИТ-сообщества, функционирующие преимущественно в цифровой среде и основанные на сетевых принципах взаимодействия, профессиональной экспертизе и распределённой координации деятельности.

В отличие от классических организаций, ИТ-сообщества характеризуются высокой степенью самоорганизации, слабой формализацией границ и преобладанием не институциональных механизмов социального порядка. Их функционирование не сводится к рамкам формальных организаций или рынков труда и во многом определяется горизонтальными коммуникациями, репутационными механизмами и участием в совместных практиках. В этом контексте ИТ-сообщества могут рассматриваться как особая форма социальной организации, отражающая более широкие изменения в структуре социального взаимодействия в условиях киберпространства. Современные социологические и междисциплинарные исследования всё чаще обращаются к анализу цифровых сообществ, однако внимание преимущественно сосредоточено либо на вопросах идентичности и профессиональной социализации, либо на технологических аспектах цифровых платформ. При этом ИТ-сообщества как самостоятельный объект анализа социальной организации остаются недостаточно концептуализированными. В частности, требуют уточнения механизмы координации, формы саморегуляции, принципы формирования и воспроизводства иерархии, а также роль платформенных условий в поддержании устойчивости таких сообществ.

Цель данной статьи заключается в теоретическом анализе ИТ-сообществ как формы социальной организации в киберпространстве. В рамках исследования рассматриваются основные социальные механизмы, обеспечивающие функционирование ИТ-сообществ, включая неформальные нормы, репутационные структуры и экспертные иерархии, а также институциональные и инфраструктурные

ограничения цифровой среды. Задачей статьи является систематизация теоретических подходов, позволяющих описать ИТ-сообщества вне рамок традиционных организационных моделей и обосновать их значение для современной теории социальной организации. Рассмотрение ИТ-сообществ в данном ключе позволяет расширить аналитические возможности социологии цифровых сообществ и создать теоретическую основу для дальнейших эмпирических исследований сетевых форм социальной организации в условиях киберпространства.

1. ИТ-сообщества в системе цифровых форм социальной организации

Развитие киберпространства сопровождается глубокой трансформацией способов социальной координации и коллективного действия. В условиях цифровизации социальная организация всё в меньшей степени определяется территориальной локализацией, формальным членством и иерархическими структурами управления. Вместо этого возрастающее значение приобретают сетевые формы взаимодействия, основанные на распределённых коммуникациях, гибких связях и технологически опосредованных практиках. Такого рода изменения создают условия для формирования устойчивых цифровых форм социальной организации, среди которых ИТ-сообщества занимают особое и методологически показательное место [1].

В теоретической перспективе современные цифровые формы социальной организации соотносятся с логикой сетевого общества, в рамках которой социальная структура формируется не через институционально закреплённые роли, а через конфигурации сетевых связей и информационных потоков [1]. Такая логика предполагает децентрализацию управления, ослабление формальной иерархии и смещение акцента с административного контроля на координацию через коммуникацию. ИТ-сообщества в этом контексте выступают как устойчивые сетевые коллективы, встроенные в инфраструктуру киберпространства и воспроизводящие собственные формы социального порядка. Существенным аналитическим ориентиром для понимания природы ИТ-сообществ является концепция сообществ практики, согласно которой социальная организация формируется вокруг совместной деятельности, обмена знаниями и освоения профессиональных практик [2]. В отличие от формальных организаций, сообщества практики не предполагают жёстко закреплённого членства или формализованных управленческих структур. Их устойчивость обеспечивается регулярным участием, признанием компетентности и воспроизводством общих стандартов деятельности. В цифровой среде ИТ-сообщества во многом воспроизводят данную логику, однако реализуют её в распределённой и технологически опосредованной форме, выходящей за рамки конкретных организаций и профессиональных институтов.

В системе цифровых форм коллективности ИТ-сообщества также следует отличать от широких онлайн-сообществ, основанных преимущественно на коммуникации или общих интересах. В отличие от них, ИТ-сообщества формируются вокруг профессиональной экспертизы, решения прикладных задач и совместного производства знаний, что придаёт им более выраженную структурированность и относительную устойчивость, несмотря на отсутствие формализованных границ и административного контроля. Такие сообщества функционируют как трансорганизационные пространства координации, в которых взаимодействие не ограничено рамками конкретных компаний, рынков труда или национальных контекстов [3].

С точки зрения теории социальной организации данная трансорганизационная природа ИТ-сообществ имеет принципиальное значение. В них координация деятельности осуществляется не через рыночные механизмы и не через иерархическое управление, а через распределённые формы сотрудничества, основанные на признании вклада, профессиональной репутации и коллективных нормах. Подобные формы социальной организации позволяют участникам координировать сложную совместную деятельность без жёсткой институциональной фиксации ролей, что делает ИТ-сообщества особенно адаптивными к изменениям технологической и профессиональной среды. Дополнительное измерение анализа связано с платформенной природой современных цифровых форм социальной организации. Цифровые платформы задают архитектуру взаимодействий, структурируют коммуникационные потоки и определяют режимы видимости участников [4]. В этих условиях ИТ-сообщества оказываются встроенными в платформенные экосистемы, которые одновременно расширяют возможности координации и накладывают инфраструктурные ограничения. Социальная организация таких сообществ формируется на пересечении коллективных практик и технических условий, задаваемых цифровыми посредниками, что усиливает зависимость процессов координации от архитектурных решений платформ.

Таким образом, ИТ-сообщества могут быть рассмотрены как особый тип цифровых форм социальной организации, сочетающий сетевую логику взаимодействий, профессиональную ориентацию и относительную институциональную автономию. Их анализ позволяет выявить переход от иерархически и институционально закреплённых моделей социальной организации к более гибким, распределённым и практико-ориентированным формам коллективного действия в условиях киберпространства. Данный теоретический контекст создаёт основу для дальнейшего рассмотрения социальных механизмов координации и саморегуляции, которые будут проанализированы в следующем разделе статьи.

2. Социальные механизмы координации и саморегуляции в ИТ-сообществах

Функционирование ИТ-сообществ как формы социальной организации в киберпространстве опирается на специфические механизмы координации и саморегуляции, принципиально отличающиеся от механизмов, характерных для формальных органи-

заций и иерархически выстроенных институциональных структур. В условиях отсутствия централизованного управления, формализованных процедур и закреплённых ролей именно эти механизмы обеспечивают устойчивость коллективных практик, согласованность действий участников и воспроизводство социального порядка.

Координация в ИТ-сообществах носит децентрализованный характер и реализуется в логике сетевого взаимодействия. В отличие от директивных моделей управления, согласование действий здесь достигается через постоянную коммуникацию, ориентацию на разделяемые профессиональные стандарты и коллективные представления о качестве результата. Такая форма координации соответствует более широкой трансформации социальной организации в условиях сетевого общества, где управление уступает место взаимодействию, а контроль – согласованию через коммуникационные процессы [1]. Существенную роль в обеспечении координации играют нормы, формирующиеся внутри ИТ-сообществ, которые как правило, не закреплены формально и не кодифицированы в виде правил, однако обладают высокой регулятивной значимостью. Они определяют допустимые формы участия, требования к профессиональному вкладу, способы взаимодействия и принципы разрешения конфликтных ситуаций. Гибкость и контекстуальная зависимость таких норм позволяют ИТ-сообществам адаптироваться к изменениям технологической и профессиональной среды без утраты устойчивости.

Важным механизмом саморегуляции в ИТ-сообществах является репутация. Репутационные оценки формируются на основе публично наблюдаемого вклада участников, качества предлагаемых решений и степени признания со стороны сообщества. Репутация выполняет координирующую функцию, способствуя распределению доверия, внимания и возможностей участия в совместных проектах. Одновременно она выступает регулятивным механизмом, формируя основания для неформального лидерства и экспертного статуса. В условиях отсутствия формальной иерархии репутация становится ключевым ресурсом социальной организации и устойчивости коллективного взаимодействия [2; 3].

Механизмы саморегуляции в ИТ-сообществах также включают систему санкций, которые носят преимущественно не институциональный и символический характер. Санкции могут выражаться в форме публичной критики, снижения репутационного статуса, ограничения доступа к совместной деятельности или исключения из ключевых коммуникационных процессов. Несмотря на отсутствие формального принуждения, такие санкции оказываются эффективными благодаря высокой значимости профессионального признания и зависимости статуса участника от коллективной оценки. Социальный порядок в ИТ-сообществах поддерживается не внешним контролем, а внутренними механизмами коллективной регуляции.

Теоретическое осмысление саморегуляции в ИТ-сообществах может быть дополнено подходами, разработанными в исследованиях коллективного управления и самоуправляемых систем. В частности, работы Элинор Остром показывают, что устойчивые формы коллективного действия могут формироваться и поддерживаться без централизованного управления при наличии разделяемых норм, механизмов мониторинга и градуированных санкций [5]. Хотя данные исследования изначально были ориентированы на анализ управления общими ресурсами, их выводы обладают высокой эвристической ценностью для понимания саморегуляции в цифровых профессиональных сообществах, включая ИТ-сообщества. Дополнительное измерение координации и саморегуляции связано с платформенными условиями функционирования ИТ-сообществ. Цифровые платформы предоставляют техническую инфраструктуру взаимодействия, но одновременно структурируют формы координации через интерфейсы, алгоритмы ранжирования и встроенные механизмы модерации [4]. Платформенные решения влияют на видимость вклада участников, приоритетность коммуникаций и доступ к ресурсам, тем самым косвенно формируя условия саморегуляции и распределения статусов внутри сообщества.

Исходя из чего делается заключение о том, что социальные механизмы координации и саморегуляции в ИТ-сообществах представляют собой сложную совокупность децентрализованных практик, неформальных норм, репутационных структур и платформенно опосредованных процессов. Такие механизмы обеспечивают устойчивость ИТ-сообществ как формы социальной организации без опоры на жёсткие институциональные рамки и централизованное управление. Их анализ создаёт теоретическую основу для дальнейшего рассмотрения вопросов репутации, экспертизы и неформальной иерархии.

3. Репутация, экспертиза и неформальная иерархия в профессиональных цифровых сообществах

Одной из ключевых особенностей ИТ-сообществ как формы социальной организации является формирование специфических режимов стратификации, основанных не на формальных статусах и организационных должностях, а на репутации, признании экспертизы и степени участия в коллективных практиках. В условиях отсутствия жёстко закреплённой иерархии именно данные механизмы обеспечивают упорядоченность взаимодействий, распределение ролей и воспроизводство социального порядка внутри профессиональных цифровых сообществ.

1) Репутация в ИТ-сообществах выступает как социальный ресурс, формируемый в процессе публично наблюдаемого участия в коллективной деятельности. Она складывается на основе качества профессионального вклада, способности решать сложные задачи и соответствия разделяемым стандартам практики. В отличие от формальных показателей квалификации, репутация в цифровых со-

обществах носит процессуальный характер и требует постоянного подтверждения через активность и видимость в сетевых взаимодействиях. Такая логика формирования статуса соответствует сетевой организации социальной структуры, в рамках которой социальное положение определяется через коммуникацию и признание, а не через институционально закреплённые позиции [1].

2) Экспертиза в ИТ-сообществах тесно связана с репутационными механизмами, но не сводится к ним. Экспертный статус формируется через признание профессиональных знаний и навыков, проявляющихся в решении прикладных задач, разработке решений и участии в совместном производстве знаний. В логике сообществ практики экспертиза является результатом длительного участия в коллективной деятельности и освоения специфических практик [2]. При этом признание экспертизы осуществляется распределённо, через совокупность оценок и реакций других участников сообщества, а не через централизованные процедуры сертификации или формального контроля.

Сочетание репутации и экспертизы приводит к формированию неформальных иерархий, которые играют существенную роль в организации взаимодействий внутри ИТ-сообществ. Как правило подобная иерархия не закреплена формально, однако оказывает заметное влияние на распределение внимания, доступ к ресурсам и возможности участия в ключевых проектах. Неформальные иерархии обладают высокой степенью гибкости и могут трансформироваться в зависимости от активности участников и актуальности их компетенций. Вместе с тем они создают условия для скрытой дифференциации статусов и возможностей, что свидетельствует о наличии структурного неравенства даже в децентрализованных формах социальной организации.

Теоретическое осмысление подобных механизмов стратификации представлено в исследованиях распределённого сотрудничества и коллективного производства, где показано, что в условиях отсутствия формального управления устойчивость коллективного действия обеспечивается через репутационные сигналы и признание вклада [3]. В ИТ-сообществах данные механизмы приобретают особую значимость, поскольку профессиональная деятельность требует высокой степени доверия к компетенциям других участников и способности ориентироваться в сложной и динамичной социальной среде.

Существенное влияние на формирование репутации и неформальной иерархии оказывают платформенные условия функционирования профессиональных цифровых сообществ. Алгоритмические механизмы ранжирования, системы оценки и интерфейсные решения не только отражают, но и активно конструируют социальную видимость вкладов участников [4]. Платформы структурируют темпы, направления и масштабы признания, усиливая эффект накопленного преимущества и закрепляя репутационные позиции отдельных участников. В результате платформенная архитектура становится не нейтральной средой взаимодействия, а активным фактором воспроизводства и стабилизации неформальной иерархии.

В условиях высокой динамики цифрового труда репутация и экспертиза приобретают выраженное временное измерение. Быстрое обновление технологий и профессиональных стандартов приводит к тому, что экспертный статус требует регулярного подтверждения и может утрачивать актуальность при снижении активности или несоответствии новым требованиям, что усиливает процессуальный характер неформальной иерархии и делает социальную структуру ИТ-сообществ подвижной и изменчивой. Данный аспект требует отдельного анализа временных и ускорительных эффектов цифровой среды, которые будут рассмотрены в следующем разделе статьи. Репутация, экспертиза и неформальная иерархия образуют взаимосвязанную систему механизмов социальной организации в ИТ-сообществах. Они обеспечивают координацию и распределение ролей без опоры на формальные институциональные структуры, но одновременно формируют устойчивые формы социальной дифференциации. Учет платформенных условий и временной динамики данных процессов позволяет более полно раскрыть специфику профессиональных цифровых сообществ и подводит к анализу институциональных и инфраструктурных ограничений их функционирования.

4. Платформенные условия и институциональные ограничения функционирования ИТ-сообществ

Функционирование ИТ-сообществ в киберпространстве в значительной степени определяется платформенными условиями, которые задают архитектуру взаимодействий, форматы участия и режимы видимости коллективной деятельности. В отличие от традиционных институциональных сред, где правила и процедуры фиксируются организационно, цифровые платформы формируют рамки социальной организации через технические решения, алгоритмические механизмы и интерфейсные настройки. В этом контексте ИТ-сообщества оказываются встроенными в инфраструктурные экосистемы, которые одновременно расширяют возможности координации и накладывают структурные ограничения.

Платформы выполняют функцию посредника между участниками ИТ-сообществ, обеспечивая доступ к коммуникационным каналам, инструментам совместной работы и механизмам публичной репрезентации вклада. Однако данное посредничество не является нейтральным. Алгоритмы ранжирования, системы рекомендаций и правила модерации структурируют потоки внимания и определяют, какие формы активности становятся видимыми и социально значимыми [4]. В результате платформенные условия начинают выполнять институциональную функцию, формируя устойчивые паттерны взаимодействия и влияя на воспроизводство социальной организации внутри ИТ-сообществ.

Существенным ограничением платформенной среды является асимметрия контроля над инфра-

структурой. В отличие от самих сообществ, платформы обладают возможностью изменять правила доступа, алгоритмы видимости и условия участия без согласования с пользователями. В таком случае сформируется ситуация институциональной неопределённости, в которой ИТ-сообщества вынуждены адаптироваться к изменяющимся внешним условиям. Социальная организация ИТ-сообществ формируется на пересечении коллективной саморегуляции и внешних инфраструктурных решений, находящихся за пределами прямого контроля участников. Платформенный детерминизм проявляется также в том, что технические параметры среды оказывают прямое влияние на социальную динамику сообществ. Интерфейсные решения задают допустимые формы взаимодействия, алгоритмы – темпы и направления признания, а метрики активности – критерии оценки вклада. В совокупности это приводит к тому, что социальные иерархии и механизмы координации в ИТ-сообществах частично воспроизводятся не через коллективные договорённости, а через встроенные логики платформенной архитектуры [4], и платформы выступают как квазиинституциональные акторы, структурирующие социальную организацию цифровых сообществ.

Отдельного внимания заслуживает временное измерение платформенных ограничений. Современные цифровые платформы функционируют в условиях ускоренной динамики, постоянного обновления и непрерывной доступности, что оказывает существенное влияние на режимы участия и воспроизводства статуса в ИТ-сообществах. Исследования временных аспектов цифровизации показывают, что ускорение коммуникаций и рост требований к постоянной активности усиливают давление на участников и снижают устойчивость профессиональных и репутационных позиций [6]. В этих условиях принадлежность к ИТ-сообществу требует непрерывного присутствия и регулярного подтверждения вклада, что ограничивает возможности долгосрочной стабилизации статусов.

Временная динамика цифрового труда, опосредованная платформами, также влияет на формы институционализации ИТ-сообществ. Отсутствие чётко закреплённых границ между рабочим и нерабочим временем, а также высокая скорость изменений технологических стандартов усиливают зависимость социальной организации от текущих режимов активности, что приводит к смещению акцента с устойчивых форм членства на процессуальные формы участия, в рамках которых социальная принадлежность постоянно как бы «пересобирается» в зависимости от контекста и интенсивности взаимодействий.

Таким образом, платформенные условия и институциональные ограничения выступают ключевым фактором, определяющим специфику функционирования ИТ-сообществ в киберпространстве. С одной стороны, цифровые платформы расширяют возможности коллективной координации и профессионального взаимодействия. С другой стороны, они формируют структурные ограничения, связанные с алгоритмическим контролем, асимметрией власти и ускоренной временной динамикой. Учет данных факторов позволяет рассматривать ИТ-сообщества не только как саморегулируемые формы социальной организации, но и как образования, чья устойчивость и внутренняя структура в значительной степени зависят от инфраструктурных и институциональных условий цифровой среды.

Заключение

Проведённый теоретический анализ позволил рассмотреть ИТ-сообщества как самостоятельную и устойчивую форму социальной организации в киберпространстве, обладающую собственной логикой функционирования и воспроизводства. В отличие от традиционных организационных моделей, основанных на формализованных иерархиях и институциональном управлении, ИТ-сообщества формируются и поддерживаются через сетевые механизмы координации, неформальные нормы, репутационные структуры и участие в совместных профессиональных практиках.

1) Рассмотрение ИТ-сообществ в системе цифровых форм социальной организации показало, что их устойчивость обеспечивается сочетанием децентрализованной координации и саморегуляции. Коллективное действие в таких сообществах опирается на разделяемые стандарты профессиональной деятельности, внутренние нормы взаимодействия и репутационные механизмы, позволяющие согласовывать действия без централизованного контроля. Так подтверждается тезис о трансформации способов социальной координации в условиях цифровизации и распространения сетевых форм коллективности.

2) Анализ репутации, экспертизы и неформальных иерархий позволил выявить специфику стратификации в профессиональных цифровых сообществах. Социальные позиции в ИТ-сообществах формируются не через формальные статусы, а через признание вклада, профессиональной компетентности и степени участия в коллективных практиках. Вместе с тем данные механизмы порождают скрытые формы социальной дифференциации, которые сохраняются даже в условиях декларируемой горизонтальности и открытости взаимодействий.

3) Особое значение в функционировании ИТ-сообществ имеют платформенные условия и институциональные ограничения цифровой среды. Платформы выступают не только техническими посредниками, но и квазиинституциональными акторами, структурирующими социальные взаимодействия через алгоритмы, интерфейсы и режимы видимости. Усиление платформенного детерминизма, а также ускоренная временная динамика цифрового труда оказывают существенное влияние на устойчивость репутационных позиций, формы участия и возможности долгосрочной институционализации ИТ-сообществ.

В целом результаты исследования свидетельствуют о том, что ИТ-сообщества следует рассматривать как гибридные формы социальной организации, находящиеся на пересечении саморегулируемых коллективных практик и внешних

инфраструктурных ограничений. Их социальная организация формируется в условиях постоянного напряжения между автономией сообществ и структурным воздействием платформенной среды. Данный вывод расширяет аналитические возможности социологии цифровых сообществ и создаёт теоретическую основу для дальнейших эмпирических исследований механизмов координации, стратификации и институционального развития ИТ-сообществ в киберпространстве.

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CYBERNETICS AND PUBLIC ADMINISTRATION: RETHINKING GOVERNANCE IN AN AGE OF COMPLEXITY

Amagoh F.
Department of Public Administration
KIMEP University
Almaty, Kazakhstan
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Abstract

Cybernetics has re-emerged as a powerful lens for understanding governance amid rapid technological change, complex socio-political systems, and increasingly unpredictable public environments. As governments confront rapidly evolving societal, technological, and geopolitical challenges, traditional bureaucratic models rooted in hierarchical control and linear planning are proving insufficient. This article provides a comprehensive examination of cybernetic theory and its applications to public administration, highlighting the contributions of first- and second-order cybernetics, systems theory, complexity science, and related governance innovations. This article examines the intellectual history of cybernetics in governance; reviews contemporary applications in public management, digital-era governance, complexity science, and algorithmic decision-making; and proposes a conceptual model of "Cybernetic Public Administration." Findings show that cybernetic principles enhance administrative capacity by supporting anticipatory governance, adaptive learning, policy coherence, and resilience. However, risks remain, including algorithmic opacity, power asymmetries, and techno-bureaucratic overreach.

Keywords: Cybernetics; Public Administration; Governance Systems; Complexity Science; Systems Theory; Digital-Era Governance; Adaptive Governance; Administrative Resilience.

1. Introduction

Public administration has undergone repeated waves of intellectual transformation as scholars and practitioners have sought to understand how governments can effectively govern increasingly complex societies. Classical public administration, rooted in Weberian bureaucracy, emphasized hierarchy, formal rules, predictability, and rational–legal authority as the foundations of administrative order and legitimacy (Weber, 1978). This model was well suited to relatively stable environments in which public problems could be decomposed, standardized, and managed through linear chains of command.

From the late twentieth century onward, however, dissatisfaction with bureaucratic rigidity and inefficiency gave rise to the New Public Management (NPM) paradigm, which introduced market-based mechanisms, performance measurement, managerial discretion, and efficiency-oriented reforms (Hood, 1991). While NPM improved cost awareness and managerial accountability in some domains, it also fragmented public authority, weakened coordination, and often struggled to address collective action problems that transcend organizational and sectoral boundaries.

Subsequent governance-oriented approaches—including network governance, collaborative governance, and digital-era governance—have further challenged the assumptions of both classical bureaucracy and NPM. These perspectives emphasize interdependence among state and non-state actors, horizontal coordination, co-production of public value, and the transformative effects of digital technologies on administrative processes (Dunleavy et al., 2006; Osborne, 2010; Leonard, 2009). Yet despite these conceptual advances, contemporary public administration continues to confront persistent limitations in its capacity to manage rapidly evolving, interconnected, and unpredictable policy environments.

In fact, many of the most pressing public problems facing governments today—such as climate change, pandemics, cybersecurity threats, misinformation ecosystems, economic volatility, large-scale migration, geopolitical instability, and global supply chain disruptions—cannot be effectively addressed through linear planning, static rules, or purely hierarchical control. These challenges are characterized by high levels of complexity, cross-sectoral interdependence, nonlinearity, and rapid change. Policy interventions often generate unintended consequences, feedback effects are delayed or distorted, and administrative systems must operate under conditions of deep uncertainty.

It is within this context that cybernetics re-emerges as a powerful and underutilized theoretical lens for public administration. Originating in the mid-twentieth century with Norbert Wiener's seminal definition of cybernetics as the study of *"control and communication in the animal and the machine"* (Wiener, 1948), cybernetics provides a coherent framework for understanding how systems regulate themselves, process information, learn from feedback, and adapt to changing environments. Rather than assuming stability, cybernetics begins from the premise that systems exist in constant interaction with dynamic and often turbulent environments. Central concepts such as feedback loops, requisite variety, self-regulation, learning, adaptation, and reflexivity offer analytical tools that are directly relevant to the challenges of contemporary governance.

Cybernetic thinking is particularly well suited to public administration because governments are, at their core, information-processing and decision-making systems. Public institutions continuously collect information about social conditions, interpret signals from their environments, formulate policies, implement interventions, evaluate outcomes, and adjust behavior

based on feedback. These processes closely mirror classical cybernetic control loops of sensing, processing, acting, and learning. When feedback is delayed, distorted, or ignored, governance systems tend to fail—an insight repeatedly confirmed by administrative crises and policy breakdowns.

Moreover, the relevance of cybernetics has intensified in the digital age. Advances in data analytics, artificial intelligence, algorithmic decision-making, and real-time monitoring systems have dramatically expanded governments' capacity to sense and respond to societal dynamics. At the same time, these technologies raise profound concerns about technocratic drift, algorithmic opacity, power asymmetries, bias, and democratic accountability.

Despite its clear relevance, cybernetics remains under-integrated into mainstream public administration theory. Existing scholarship often treats cybernetics as either a historical curiosity or a narrow technical approach focused on control and efficiency. Less attention has been paid to how first- and second-order cybernetic principles can be systematically integrated with contemporary governance theories, democratic norms, and digital-era administrative practices. As a result, public administration lacks a coherent framework for harnessing cybernetic insights while simultaneously safeguarding reflexivity, participation, and legitimacy.

This paper seeks to address this gap by advancing a comprehensive cybernetic perspective on public administration. It revisits the intellectual foundations of cybernetics, examines its intersections with systems theory, complexity science, and governance scholarship, and explores its contemporary applications in digital governance and algorithmic administration. Building on this synthesis, the article proposes a conceptual model of ***Cybernetic Public Administration*** that emphasizes adaptive learning, high-quality feedback, reflexive decision-making, and democratic safeguards.

2. Literature Review

Cybernetics has increasingly re-emerged as a foundational theoretical framework for understanding governance and administrative systems, particularly in contexts characterized by complexity, uncertainty, and rapid technological change. The literature on cybernetics and public administration spans several generations of scholarship, each contributing distinct perspectives on control, communication, decision-making, adaptation, and reflexivity in governance.

2.1 First-Generation Cybernetics: Feedback, Control, and Communication

The foundational works of Wiener (1948), Ashby (1956), and Shannon (1948) established cybernetics as the study of feedback, control, and communication across biological and mechanical systems. Wiener emphasized that systems maintain order through negative feedback loops, enabling stability and error correction. Ashby introduced the *Law of Requisite Variety*, which asserts that only a system with adequate internal complexity can effectively regulate a complex environment. These principles laid the groundwork for understanding public administration as a regulatory, information-processing system (Beishon & Peters, 1972).

Early applications of cybernetics in the administrative sciences focused on decision-making processes, organizational control, and performance management. Simon (1947) conceptualized administrative behavior as a boundedly rational information-processing activity, structurally analogous to cybernetic models of perception, processing, and feedback. Easton's (1965) political systems model similarly mirrors cybernetic logic, depicting governance as an ongoing cycle of inputs, processing, outputs, and feedback.

2.2 Second-Order Cybernetics and Governance

While first-generation cybernetics focused on control, regulation, and feedback mechanisms within observable systems, ***second-order cybernetics*** fundamentally reoriented cybernetic inquiry by turning attention to the role of the observer, reflexivity, and self-referential processes. Pioneered by scholars such as Foerster (1984), Gregory Bateson (1972), George Herbert Mead (1968), and later Maturana and Varela (1980), second-order cybernetics challenged the assumption that systems could be governed or analyzed from an objective, external standpoint.

At its core, second-order cybernetics argues that ***observers are part of the systems they observe***. Knowledge, control, and regulation are therefore not neutral or external operations but are shaped by cognitive frames, communicative practices, power relations, and normative assumptions. This shift has profound implications for public administration, where governance is not merely a technical process of steering systems toward predefined goals, but a socially constructed, interpretive, and politically embedded activity.

Reflexivity and the Role of the Administrator

In public administration, second-order cybernetics reframes administrators not as detached controllers of social systems, but as ***embedded actors who co-produce governance outcomes***. Administrative decisions influence system behavior, which in turn reshapes administrative perceptions, priorities, and institutional routines. Governance thus becomes a recursive process in which policies both respond to and actively constitute social realities.

This insight aligns closely with interpretive and constructivist approaches in public administration. Scholars such as Bevir and Rhodes (2003) emphasize that governance is shaped by beliefs, traditions, and narratives rather than by objective system imperatives alone. From a second-order cybernetic perspective, administrative systems are sustained through ongoing communicative processes in which meaning is negotiated rather than imposed. Policy "feedback" is therefore not simply data about performance, but socially interpreted information filtered through institutional norms, political interests, and cognitive biases.

From Control to Communication

Second-order cybernetics shifts the analytical focus from ***control to communication***. Whereas first-order cybernetics prioritizes negative feedback loops that correct deviations from predefined goals, second-order cybernetics highlights how goals themselves are constructed, contested, and revised through interaction. This is especially relevant in pluralistic societies where policy objectives are rarely consensual and where legitimacy depends on deliberation, inclusion, and transparency.

This communicative emphasis resonates strongly with deliberative and collaborative governance models. Ansell and Gash's (2008) theory of collaborative governance, for example, conceptualizes policy outcomes as emerging from iterative dialogue among interdependent actors rather than from centralized command. Similarly, co-production frameworks (Brandsen & Honingh, 2016) emphasize that public value is jointly produced by governments, citizens, and civil society. Second-order cybernetics provides the underlying theoretical logic for these models by explaining how governance systems evolve through recursive communication rather than linear intervention.

Self-Reference, Autopoiesis, and Governance Systems

A key contribution of second-order cybernetics is the concept of ***self-referential or self-producing systems***. Building on Maturana and Varela's (1980) notion of autopoiesis, social systems theory—most notably in the work of Luhmann (1995)—argues that governance systems reproduce themselves through communication. From this perspective, public administration does not directly "control" society; rather, it selectively responds to environmental signals according to its own internal codes, routines, and institutional logics.

For public administration, this implies that reform initiatives, performance indicators, and feedback mechanisms are always mediated by organizational self-reference. Administrative systems tend to privilege information that aligns with existing priorities and discount signals that challenge dominant paradigms. Second-order cybernetics thus helps explain why governments often fail to learn from crises, ignore early warning signals, or reproduce dysfunctional policies despite abundant data.

2.3 Cybernetics, Systems Theory, and Complexity in Public Administration

Significant literature links cybernetics to systems theory and complexity science, which have deeply influenced public administration (Teisman & Klijn, 2008; Geyer & Rihani, 2010). Systems theorists such as Bertalanffy (1968) and Luhmann (1995) conceptualized society as an interconnected web of subsystems, where communication—not structure—is the fundamental unit of governance. Luhmann's idea of autopoiesis, derived from Maturana and Varela (1980), expanded the cybernetic lens by arguing that social systems are self-producing through communication.

Complexity scholars later built on these insights to examine emergent behavior, nonlinear dynamics, and adaptive governance (Holland, 1995; Kauffman, 1993). Public administration research has incorporated these ideas into analyses of: wicked problems (Rittel & Webber, 1973); multi-level governance dynamics (Hooghe & Marks, 2001); cross-sector collaboration (O'Toole, 1997); and network resilience and robustness (Comfort, 1994; 2019). Cybernetics provides the underlying logic for understanding how systems sense, interpret, and respond to changes—offering practical tools for governance in complex environments.

2.4 Cybernetic Organizational Models in the Public Sector

A central contribution of cybernetic theory to public administration lies in its application to ***organizational design and administrative capacity***. Unlike traditional organizational theories that emphasize hierarchy, formal authority, or static structures, cybernetic organizational models focus on ***viability, adaptability,*** **and** ***learning*** in environments characterized by complexity and uncertainty. These models conceptualize public organizations not as closed bureaucratic machines, but as open, self-regulating systems that must continuously adjust their internal structures to cope with external variety.

The Viable System Model and Public Organizations

Among cybernetic organizational frameworks, **Stafford Beer's *Viable System Model (VSM)*** represents the most systematic attempt to translate cybernetic principles into practical organizational design. Developed in *Brain of the Firm* (1972) and *The Heart of Enterprise* (1979), the *VSM* specifies the minimum functional requirements necessary for any organization—public or private—to remain viable in a changing environment.

The *VSM* identifies five interdependent subsystems:

1. ***System 1 (Operations)*****:** Units responsible for delivering core services and interacting directly with the environment (e.g., frontline agencies, service providers, regulatory units).

2. ***System 2 (Coordination)*****:** Mechanisms that harmonize interactions among operational units, reducing oscillation and conflict (e.g., inter-agency coordination bodies, shared standards, information systems).

3. ***System 3 (Control and Optimization)*****:** Internal regulation, resource allocation, performance monitoring, and accountability mechanisms (e.g., budgeting, auditing, managerial oversight).

4. ***System 4 (Intelligence and Adaptation)*****:** Strategic scanning, foresight, policy analysis, and learning functions that connect the organization to future environmental changes (e.g., planning units, research departments, horizon-scanning teams).

5. ***System 5 (Policy and Identity)*****:** Normative decision-making, mission definition, values, and constitutional authority that balance present operations with future adaptation (e.g., political leadership, constitutional frameworks, public values).

This arrangement is particularly relevant to public sector organizations, which must simultaneously ensure operational reliability, political legitimacy, and long-term adaptability. Unlike private firms, public organizations face multiple and often conflicting objectives, intense public scrutiny, and legal–constitutional constraints. The *VSM* provides a cybernetic lens for understanding how these competing demands can be balanced without sacrificing systemic coherence.

2.5 Digital Governance and Algorithmic Cybernetics

Recent literature links cybernetics to digital-era governance, particularly through data-driven decision systems, algorithmic regulation, and real-time administrative platforms. Dunleavy et al. (2006) argued that digital transformation reintroduces cybernetic logic by strengthening information flows and feedback loops. Algorithmic governance scholars contend that automated decision systems amplify the cybernetic ideal of continuous adaptation, yet introduce concerns about opacity, bias, and democratic legitimacy (Yeung, 2018; Eubanks, 2018). Other strands of literature examine: smart cities and cyber-physical governance (Kitchin, 2014); predictive analytics in policing and social services (Meijer & Wessels, 2019); digital feedback platforms (Lee & Kwak, 2012); and real-time data dashboards for service delivery (Scholl & Scholl, 2014).

These studies highlight the convergence of cybernetic principles with emerging technologies but also warn of risks such as over-centralization, technocratic governance, and the erosion of public accountability.

3. Methodology

This paper adopts a qualitative conceptual research design combining systematic literature review, theoretical synthesis, and analytical framework development. Given the broad, interdisciplinary nature of cybernetics and public administration, a conceptual methodology is most appropriate for theory-building and integration across diverse research traditions. The study follows a qualitative research strategy that consists of a systematic literature review on cybernetics (first- and second-order), systems theory, complexity science, public administration theory, digital governance and algorithmic regulation, organizational design and learning, regulatory governance, and smart cities and cyber-physical systems. The review covered peer-reviewed journal articles, foundational books, and contemporary research reports. Searches were conducted using Scopus, Web of Science, JSTOR, Google Scholar, SSRN, Public Administration Review archives, and Government Information Quarterly archives**.**

4. Cybernetics Public Administration: Conceptual Linkages

4.1 Governments as Information-Processing Systems

Public administration scholars like Simon (1947), Lindblom (1959), and Easton (1965) emphasized that governmental decision-making relies heavily on information processing. Cybernetics provides a coherent conceptual foundation for viewing the state as a *Complex Information-processing Organism.* Governments engage in: sensing (data collection); processing (analysis, deliberation); deciding (policy action); responding (implementation); and learning (evaluation and adjustment). This mirrors the cybernetic loop of *input–processing–output–feedback. T*he efficiency of governance depends on: timeliness and accuracy of information; learning mechanisms; ability to detect failures; and communication flows across agencies and levels. Cybernetic theory highlights that *information delays*, *poor communication*, and *rigid structures* can cause system failures—insights that remain highly relevant.

4.2 Feedback Mechanisms in Governance

Cybernetics proposes that systems survive through continuous feedback. In governance, feedback comes from: citizens (complaints, surveys, elections); performance indicators; audits and inspections; civil society monitoring; market reactions; media scrutiny; and digital platforms and social networks. The quality of governance depends on: feedback quality (accuracy, completeness); feedback frequency (real-time vs slow); feedback responsiveness (ability to act); and feedback legitimacy (trust, participation). Systems with delayed or distorted feedback (e.g., authoritarian regimes with censored information) often experience policy failures, consistent with cybernetic predictions (Hayek, 1945).

4.3 Adaptive Governance and Organizational Learning

Adaptive governance occupies a central place in cybernetic approaches to public administration. At its core, cybernetic theory views governance systems as ***learning systems*** that must continuously adjust their behavior in response to feedback from complex and changing environments. As Ashby's (1956) *Law of Requisite Variety* suggests, only systems capable of learning and adaptation can remain viable when environmental complexity exceeds the capacity of static rules or fixed institutional designs. In public administration, this insight directly challenges traditional models that rely on stability, standardization, and ex ante planning as primary sources of control.

Cybernetic Foundations of Adaptive Governance

From a cybernetic perspective, adaptive governance emerges from the ***recursive interaction between feedback, decision-making, and learning***. Public institutions sense changes in their environment through data collection, monitoring, and stakeholder feedback; process this information through administrative routines and deliberative mechanisms; act through policy interventions; and subsequently evaluate outcomes. Learning occurs when feedback leads to meaningful adjustment in policies, procedures, or governing assumptions.

Unlike command-and-control models, cybernetic governance does not assume that optimal solutions can be fully specified in advance. Instead, policies are treated as ***provisional hypotheses*** subject to continuous testing and revision. This logic aligns closely with contemporary understandings of governance under uncertainty, where prediction is limited and adaptability becomes a key source of administrative capacity.

Organizational Learning: Single-, Double-, and Triple-Loop Dynamics

Cybernetic theory provides a structured way of understanding ***organizational learning*** in public administration. Building on Argyris and Schön's (1978) influential framework, learning can be conceptualized at multiple levels:

- ***Single-loop learning*** involves correcting errors or deviations while leaving underlying goals, norms, and institutional structures intact. In public administration, this often takes the form of incremental policy adjustments, performance target recalibration, or procedural refinements.
- ***Double-loop learning*** occurs when feedback prompts reconsideration of the assumptions, values, or

problem definitions that guide policy. Examples include rethinking welfare conditionality, policing strategies, or regulatory philosophies in response to persistent failure or public contestation.

- ***Triple-loop learning***, sometimes associated with second-order cybernetics, extends reflexivity further by questioning how governance systems learn, who defines learning criteria, and whose knowledge counts. This level of learning engages issues of power, legitimacy, and institutional self-awareness.

Adaptive governance requires not only the capacity for single-loop optimization, but also institutionalized mechanisms for deeper forms of learning (Espejo & Reyes, 2011; Schwaninger, 2006). Cybernetic theory highlights that without double- and triple-loop learning, governance systems may become efficient at reproducing failure.

Learning Under Complexity and Uncertainty

Public governance increasingly operates under conditions of ***radical uncertainty***, where causal relationships are ambiguous and policy outcomes are emergent rather than predictable. Complexity theory reinforces cybernetic insights by showing that interventions in complex adaptive systems often generate nonlinear and unintended effects (Holland, 1995; Kauffman, 1993). Adaptive governance therefore depends less on precise control and more on ***continuous sense-making***, experimentation, and feedback sensitivity.

Cybernetic approaches emphasize that learning in such contexts must be iterative and distributed. Centralized learning systems often suffer from information overload, delayed feedback, and political filtering. In contrast, adaptive governance benefits from decentralized learning structures that allow frontline actors, local governments, and network partners to experiment and share insights. These distributed feedback loops enhance system-wide learning and increase the internal variety necessary to cope with environmental complexity.

Policy Experimentation and Iterative Design

One of the most concrete expressions of cybernetic learning in public administration is ***policy experimentation***. Pilot programs, regulatory sandboxes, randomized controlled trials, and adaptive implementation strategies embody cybernetic logic by treating policies as evolving interventions rather than fixed commands. Feedback from these experiments informs subsequent adjustments, enabling learning before large-scale rollout.

Iterative policy design—often associated with agile governance and design thinking—further reflects cybernetic principles. Rather than pursuing comprehensive reforms based on static blueprints, governments incrementally refine policies through cycles of testing, evaluation, and revision. Cybernetic theory provides the conceptual justification for these approaches by demonstrating that learning, not prediction, is the primary mechanism of effective governance in complex environments.

Feedback Quality and Learning Capacity

Cybernetic governance emphasizes that ***not all feedback is equally conducive to learning***. The effectiveness of adaptive governance depends on several attributes of feedback systems:

- ***Timeliness*:** Delayed feedback reduces learning capacity and increases the risk of policy overshoot or inertia.
- ***Accuracy*:** Distorted or politically filtered information undermines corrective learning.
- ***Diversity*:** Narrow indicators limit learning, while diverse qualitative and quantitative feedback expands informational variety.
- ***Interpretability*:** Data must be meaningful and actionable for decision-makers at different levels.

Public administration literature on performance management often documents learning failures caused by overly rigid indicators, gaming behavior, or compliance-oriented evaluation systems (Bevan & Hood, 2006). Cybernetic theory explains these failures as ***pathological feedback loops***, where incentives distort signals and learning becomes decoupled from real-world outcomes.

4.4 Regulating Complex Systems

Regulation is one of the domains in which cybernetic principles are most directly and enduringly embedded in public administration. From a cybernetic perspective, regulation is fundamentally a process of ***continuous system steering*** rather than one-time rule-setting. Regulatory systems seek to shape behavior by establishing norms, monitoring compliance, interpreting feedback, and adjusting interventions in response to changing conditions. This recursive logic closely mirrors classical cybernetic control loops of goal-setting, sensing, comparison, correction, and learning.

Cybernetic Logic of Regulation

Traditional regulatory models often assume that social and economic systems are sufficiently stable and predictable to be governed through fixed rules and ex ante compliance mechanisms. Cybernetic theory challenges this assumption by emphasizing that regulated systems—such as markets, financial institutions, environmental systems, digital platforms, and public services—are ***complex adaptive systems*** characterized by strategic behavior, feedback effects, and unintended consequences.

From a cybernetic standpoint, effective regulation requires the capacity to ***continuously observe system behavior***, detect deviations or emerging risks, and recalibrate regulatory responses. Regulation is therefore not a static instrument but a dynamic process of information processing and learning. Failures of regulation are frequently attributable to breakdowns in feedback—such as delayed data, information asymmetries, regulatory capture, or rigid enforcement routines that cannot adapt to system evolution.

Responsive and Reflexive Regulation as Cybernetic Models

Contemporary regulatory theories explicitly incorporate cybernetic principles. ***Responsive regulation***, developed by Ayres and Braithwaite (1992), conceptualizes regulation as a graduated, feedback-driven process in which enforcement strategies escalate or de-escalate based on regulated actors' behavior. Rather than imposing uniform sanctions, responsive regulation relies on continuous monitoring and learning, allowing regulators to adapt interventions in light of observed outcomes.

Similarly, ***reflexive regulation*** (Black, 2001) emphasizes the capacity of regulatory systems to reflect on their own assumptions, instruments, and effects. Reflexive regulation recognizes that regulators cannot fully control complex systems and therefore seek to shape self-regulation, learning, and norm internalization among regulated actors. From a cybernetic perspective, reflexive regulation represents a second-order regulatory approach that focuses not only on controlling behavior, but on influencing how systems regulate themselves.

Regulating Nonlinear and Emergent Risks

Many contemporary regulatory challenges involve ***nonlinear dynamics and emergent risks***. Financial crises, environmental tipping points, public health emergencies, and digital misinformation cascades often develop through feedback amplification rather than incremental change. Cybernetic theory is particularly valuable in these contexts because it foregrounds early warning signals, feedback sensitivity, and system thresholds.

Adaptive regulatory regimes therefore prioritize ***anticipatory governance***—including stress testing, scenario analysis, horizon scanning, and continuous risk monitoring. These tools function as cybernetic sensing mechanisms that enable regulators to detect weak signals before they escalate into systemic failure. Regulatory systems that lack such anticipatory capacities tend to respond only after crises have fully materialized, when corrective interventions are more costly and less effective.

Multi-Level and Networked Regulation

Regulation increasingly operates across ***multiple levels of governance*** and through networks of public and private actors. National regulators coordinate with international organizations, subnational authorities, industry bodies, and civil society groups. Cybernetic theory offers a framework for understanding how regulatory coherence can be maintained in the absence of centralized control.

In multi-level systems, coordination and communication—rather than hierarchical authority—become the primary regulatory mechanisms. Effective regulation depends on aligning feedback loops across levels, ensuring that local knowledge informs central oversight and that strategic objectives guide decentralized implementation. Cybernetic analysis helps explain why fragmented regulatory systems often fail: feedback becomes siloed, learning is localized, and systemic risks go undetected.

5. Cybernetic Applications in Contemporary Governance

Cybernetics can be meaningfully applied to various areas of contemporary governance as follows:

- *Digital Government and Algorithmic Governance*: Digital transformation has dramatically enhanced governments' information-processing capacities. Many modern administrative tools are fundamentally cybernetic: Examples include: predictive analytics for welfare fraud detection; algorithmic policing systems; digital tax administration; real-time dashboards for monitoring public services (e.g., 311 systems); and automated eligibility systems for social programs. These systems rely on: real-time data inputs; automated processing; decision outputs; and feedback loops for recalibration. Scholars of "algorithmic governance" argue that automated systems increasingly instantiate cybernetic control architectures at scale (Yeung, 2018).
- *Smart Cities and Cyber-Physical Governance*: Smart cities use sensors and platforms to govern through continuous feedback. Examples include: adaptive traffic control systems; smart energy grids; waste optimization platforms; water management systems; and public safety surveillance systems. These systems operate as real-time cybernetic loops, adjusting outputs dynamically based on environmental changes.
- *Crisis Management and Cybernetic Resilience*: Disaster response and crisis management rely on rapid information flows and adaptive coordination. The success of pandemic response systems (COVID-19), early-warning systems for natural disasters, and cybersecurity defense networks depends on: fast, accurate feedback; dynamic coordination; continuous learning; and redundancy and resilience. Cybernetic resilience emphasizes not only stability but also *transformative adaptation* (Folke et al., 2010).
- *Performance Management Systems*: Performance measurement, dashboards, scorecards, and target systems exemplify cybernetic control logic:

Goals → Indicators → Monitoring → Feedback → Adjustment.

While widely used, critics argue that poorly designed indicators distort administrative behavior (Bevan & Hood, 2006), creating dysfunctional feedback loops—an insight perfectly aligned with cybernetic theory.

6. Challenges and Critiques

Cybernetics has been accused of the potential for technocratic bias. Critics argue that cybernetic approaches risk overemphasizing efficiency and control at the expense of: citizen participation; democratic deliberation; equity and fairness; and cultural judgment. Thus, critics argue that cybernetic governance may drift toward technocracy if not balanced with democratic norms (Habermas, 1984). The second criticism is cybernetics over-reliance on quantification. It is argued that cybernetics prioritizes quantifiable feedback, which may obscure: qualitative experiences; cultural dynamics; tacit knowledge; and political values. Public administration involves human judgment that cannot be fully reduced to data.

Third, there is the potential problem of algorithmic risks and bias. Algorithmic governance—an extension of cybernetic logic—poses: bias and discrimination risks; opaque decision processes; automation overreach; data privacy concerns; and manipulability through adversarial inputs. These create *"pathological feedback loops"* where algorithms reinforce systemic inequalities (Eubanks, 2018). Fourth, one cannot overlook the problem of organizational resistance. Adaptive governance requires: information-sharing; coordination; cultural change; and new competencies. Bureaucratic inertia and siloed structures often impede cybernetic reforms (Peters, 2010). Finally, cybernetics warns that increasing environmental variety requires increasing internal variety—yet governments face resource

constraints. Increasing complexity may overwhelm administrative systems unless designed with: redundancy; modularity; adaptive capacities.

7. Conclusion

Cybernetics offers a powerful and underutilized conceptual framework for rethinking public administration in an era marked by escalating complexity, interdependence, uncertainty, and rapid digital transformation. By foregrounding feedback, communication, learning, adaptation, and reflexivity, cybernetic theory moves beyond static, hierarchical models of governance and instead conceptualizes public administration as a dynamic system continuously interacting with its environment. This perspective is particularly well suited to contemporary governance contexts characterized by nonlinearity, policy volatility, cross-sectoral interdependence, and unpredictable societal risks.

As governments increasingly deploy data-driven tools, algorithmic decision-making systems, artificial intelligence, and digital infrastructures, cybernetic principles acquire renewed empirical and normative relevance. Real-time data flows and automated feedback loops promise more responsive and adaptive governance, enabling public institutions to monitor performance, detect early warning signals, and adjust policies dynamically. However, the expansion of computational governance also introduces significant risks. Technocratic drift, opacity in algorithmic systems, bias embedded in data and models, and the potential erosion of democratic accountability underscore the limits of purely technical or efficiency-driven cybernetic applications. Without explicit democratic grounding, cybernetic governance risks becoming self-referential, exclusionary, and detached from public values.

Consequently, future governance must be grounded in a *hybrid cybernetic model*—one that integrates technological sophistication with democratic reflexivity. Such a model combines:

- ***Real-time data*** to enhance situational awareness and anticipatory capacity;
- ***Adaptive control mechanisms*** that allow policies and institutions to evolve in response to changing conditions;
- ***Participatory feedback channels*** that incorporate citizen input, societal learning, and deliberative engagement;
- ***Reflexive decision-making*** that critically examines assumptions, goals, and unintended consequences; and
- ***Ethical and democratic safeguards*** that ensure transparency, accountability, inclusiveness, and normative legitimacy.

In this hybrid formulation, cybernetics is not reduced to a technocratic toolkit but re-imagined as a governance philosophy that aligns system intelligence with public reason and democratic values. Reflexivity becomes as important as efficiency, and learning is understood not only as technical optimization but also as institutional self-critique and normative re-calibration.

Ultimately, cybernetic thinking—once dismissed as abstract or overly theoretical—has become central to understanding and designing governance systems capable of resilience, adaptability, and legitimacy in the digital age. By integrating cybernetic principles with democratic governance, public administration can better navigate complexity while remaining responsive to citizens, accountable to public values, and capable of collective learning. This synthesis positions cybernetics not as a replacement for democratic governance, but as a vital intellectual foundation for building intelligent, resilient, and genuinely democratic public institutions in the twenty-first century.

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THE BACKGROUND AND IMPACT OF DECENTRALIZATION IN UKRAINE ON THE COUNTRY'S EUROPEAN INTEGRATION

Lőrinc I.
PhD student, Doctoral School of History and Ethnography
University of Debrecen, Debrecen, Hungary
https://orcid.org/0009-0006-8928-6667
https://doi.org/10.5281/zenodo.18070653

Abstract

In Ukraine, the so-called decentralization reform began in 2014 with the aim of fundamentally transforming the country's administrative structure. It is beyond dispute that this large-scale reform (one that does not occur every decade) has faced extraordinary challenges from the outset. First, its implementation was disrupted by the COVID-19 pandemic and subsequently by the outbreak of war, which continues to shape both the pace and the scope of the reform process. Moreover, despite having been launched more than eleven years ago, the reform has not yet fully completed its implementation phase as of December 2025.

Nevertheless, the experiences, lessons, and partial results accumulated over the past eleven years provide a solid basis for examining the reform from a scientific perspective, particularly with regard to the changes initiated in the context of European integration and harmonization. Numerous studies have assessed the effectiveness of the reform across various sectors, while mass media sources increasingly report that, due to the ongoing crises, further radical changes may still lie ahead.

The aim of the present study is to explore the background of the decentralization reform and its practical implementation through a review of the relevant scholarly literature and empirical research.

Keywords: Ukraine, decentralization, reform, European integration.

The Theoretical Approach to Decentralization

According to the academic literature, the decentralization of power does not constitute a single, autonomous, or isolated reform. Rather, it represents a set of interrelated measures aimed at the deliberate and systematic transformation of the administrative system, implemented consistently and incrementally through a step-by-step process [12, pp. 68–70].

The *Concept for the Reform of Local Self-Government and the Territorial Organization of Power in Ukraine*, approved in April 2014, set as its primary objectives the decentralization of power, the strengthening of local communities, and the improvement of the quality of public services. Adopted in the immediate aftermath of the Revolution of Dignity, this policy document sought to establish a more efficient and citizen-oriented system of local governance, while simultaneously fostering the development of direct democracy and balancing the interests of the state and territorial communities.

Although the Concept was not adopted as a law, it nonetheless provided a crucial framework for regulating and implementing the decentralization reform. Structured around the identification of key problems, the formulation of objectives, and the definition of fundamental principles, tasks, and stages, the document highlighted systemic deficiencies such as the poor quality of public services, the limited competences of local decision-making bodies, and the underdeveloped mechanisms of direct democracy.

The Concept identified four main priorities:

1. ensuring access to public services;
2. clearly delineating competences between local self-government bodies and executive authorities;
3. establishing a rational territorial basis for the organization of public authority;
4. creating adequate financial conditions for local self-government bodies [9].

The necessity of the reform was further underscored by the shortcomings of the existing local self-government system at the time. In practice, only regional centers and cities of regional significance functioned effectively, while smaller settlements lacked sufficient financial and material resources and were therefore unable to provide public services at an appropriate standard [9].

Historical Overview

Following the attainment of independence, Ukraine made several attempts to address issues related to administrative reform. The first step toward establishing an independent administrative system was taken after 1990. On 7 December 1990, the Law of Ukraine "*On Councils of People's Deputies and Local Self-Government"* was adopted, marking the beginning of administrative reform in independent Ukraine [10]. This date is still commemorated as the Day of Local Self-Government.

In 1997, Ukraine ratified the *European Charter of Local Self-Government*. Adopted in Strasbourg in 1985, the Charter is one of the cornerstone documents of democratic governance. It aims to strengthen local self-government and protect its autonomy, based on the principle that democracy can function effectively only when citizens are able to participate directly in the management of public affairs, particularly at the local level. The Charter stipulates that the right to local self-government must be guaranteed by the constitution or by law, and that local authorities must have the right, within the limits of the law, to regulate and manage a substantial share of public affairs under their own responsibility.

Furthermore, the Charter requires that the powers and responsibilities of local self-government bodies be clearly defined by law and that adequate organizational, human, and financial resources be ensured. Financial autonomy is recognized as a fundamental principle: local authorities must possess their own financial resources commensurate with their responsibilities and must be entitled to participate in determining local taxes and charges. The Charter also emphasizes the right of local authorities to associate, enabling cooperation with other municipalities and the establishment of international relations. Another key element is legal protection, which grants local authorities the right to seek judicial remedies when their autonomy is violated [2].

Contracting states are required to consider at least twenty provisions of the Charter as binding, including ten core articles, thereby ensuring that the principles of local self-government are genuinely integrated into national legal systems and governance practices. As such, the Charter constitutes the fundamental European framework for local democracy, decentralization, and community participation.

The overarching goal of the decentralization reform is to establish effective local self-government and a coherent territorial organization of power capable of creating and maintaining a full-fledged living environment for citizens, ensuring high-quality and accessible public services, developing institutions of direct popular sovereignty, and harmonizing the interests of the state and local communities. Within this framework, local self-government bodies are accountable to residents for the effectiveness of their activities and to the state for their legality [8, p. 113].

Another significant milestone occurred on 22 July 1998, when President Leonid Kuchma signed Decree No. 810/98 *On Measures for the Implementation of the Concept of Administrative Reform in Ukraine*. Although innovative in scope, the 1998 Concept largely remained theoretical in nature and reflected partially developed Soviet–European reform ideas [13, p. 102].

Between 2000 and 2013, several further attempts were made to restructure local administration in Ukraine; however, these initiatives either failed or produced limited results [13, p. 100].

The decentralization process gained real momentum in 2014 with the adoption of the 2014 Concept and the enactment of key legislative acts, including the Law "On Cooperation of Territorial Communities" (17 June 2014), the Law "On Voluntary Amalgamation of Territorial Communities" (5 February 2015), and amendments to the Budget Code and the Tax Code aimed at implementing financial decentralization [13, p. 104].

At the outset of the reform, only six regions in Ukraine were financially self-sustaining, resulting in significant regional disparities in living standards and service quality. These imbalances underscored the urgent need for comprehensive reform in public administration, local government, and the territorial organization of power [12, pp. 68–70].

The decentralization reform stimulated the development of local self-government as the level of authority closest to citizens. Through the voluntary amalgamation of territorial communities, newly established local governments acquired powers and resources previously reserved for cities with county rights. Citizens' interests within amalgamated communities are represented by elected mayors, representative councils, and executive bodies exercising legally defined competences. In settlements belonging to these communities, local self-government and access to public services are ensured by locally elected leaders (*starosts*).

Democracy remains the most widely valued form of socio-political organization, as it enables citizens not only to elect their leaders but also to exercise control over public power. Despite its challenges, democratic governance is best equipped to respond to the complexities of contemporary society.

Prior to decentralization, the excessive concentration of power in Ukraine resulted in:

– strong regional dependence on the central government;
– low investment attractiveness;
– weak communities in terms of infrastructure, finances, and human resources;
– rural decline;
– unfavorable demographic trends;
– low-quality public services;
– widespread distrust of authorities;
– high levels of corruption;
– low efficiency in decision-making [13].

Practical Results of the Reform

As a result of the reform process, and in line with the principles of the European Charter of Local Self-Government, a strong and functional basic level of local governance has been established through the system of united territorial communities (*OTG*). Over six years, 1,070 OTGs were formed, incorporating 4,882 municipalities through voluntary amalgamation. Of these, 936 communities held their first local elections.

The government approved community formation plans in all 24 regions, covering their entire territories. The new OTGs encompass approximately 47% of Ukraine's territory, while more than 70% of the population resides in these communities and in cities with county rights. Pursuant to Law No. 562-IX of 16 April 2020, the Cabinet of Ministers designated administrative centers and approved the boundaries of 1,470 viable territorial communities. Local elections were subsequently held in 2020 based on the new territorial structure.

Inter-municipal cooperation further expanded the capacity of local governments by enabling resource coordination and the implementation of joint projects. Within this framework, 1,354 communities concluded a total of 604 cooperation agreements [11].

Decentralization and European Integration

The criteria and rules established at the 1993 Copenhagen European Council meeting determine whether a country is eligible to join the European Union. According to these criteria, states applying for EU membership must possess stable institutions guaranteeing democratic governance, the rule of law, and the protection of human rights, as well as a functioning market

economy. In addition, candidate countries are required to accept and implement the obligations arising from EU membership.

These requirements are further reflected in Article 49 of the Treaty on European Union (TEU), which stipulates that any European state wishing to accede to the EU must fulfil the following conditions:

– the existence of stable political institutions and guarantees of human rights and the rule of law;

– economic stability and a functioning market economy capable of coping with competitive pressure and market forces within the EU;

– acceptance of the acquis communautaire, that is, the body of EU law developed since the beginning of European integration in the 1950s [1, p. 25].

Decentralization is directly linked to the political criteria of EU accession. By strengthening local self-government and redistributing power away from the central level, decentralization enables citizens to participate more actively in decision-making processes, increases transparency, and reduces opportunities for corruption. In this way, decentralization brings Ukraine closer to the democratic standards expected by the European Union.

The European Commission consistently emphasizes the importance of supporting local governments so that they can independently design and implement local policies, contribute to sustainable development, and improve the quality of public services. From this perspective, the decentralization reform is closely connected to the EU accession process, as it fosters the development and consolidation of democratic institutions [5].

The decentralization reform is closely linked to the criteria for accession to the European Union, as it promotes the strengthening of democratic institutions, increased transparency, and the rule of law in decision-making at the national and local levels. The EU's accession requirements, as set out in the Copenhagen criteria and Article 49 of the TEU, require candidate countries to have stable political institutions, to ensure the protection of human rights and the rule of law, and to have a functioning and transparent public administration system.

In Ukraine, the decentralization of power strengthens local authorities and brings decision-making closer to citizens, enabling broader public participation in the management of community and public affairs. Greater autonomy of local communities allows residents to exercise direct control over local decision-making, including budgetary matters, infrastructure development, and the provision of public services. This, in turn, enhances transparency, limits the potential for corruption, and strengthens public trust in both local and national institutions.

Democratic mechanisms such as the election of local representative bodies and mayors, as well as citizen involvement in community-level decision-making, play a key role in ensuring the rule of law. These mechanisms ensure that power is exercised within a legal framework and in the interests of the local population. Furthermore, financial autonomy – an essential component of decentralization – enables local governments to manage their own revenues and allocate resources according to local priorities, thereby promoting sustainable economic development and more efficient public administration.

From the EU's perspective, transparency and the rule of law are not merely formal requirements but fundamental conditions for effective governance that can be monitored and evaluated by citizens. Accordingly, Ukraine's decentralization reform strengthens not only administrative capacity but also political accountability and democratic values, directly contributing to the fulfilment of EU accession criteria.

Overall, the strengthening of local self-government, the introduction of direct participation mechanisms, the assurance of financial and legal autonomy, and transparent and accountable decision-making all contribute to the development of democratic institutions, the enforcement of the rule of law, and the reduction of corruption. These factors support Ukraine's alignment with European Union expectations while simultaneously enhancing citizens' trust and active participation in local community life [6].

EU Recommendations and Support Mechanisms

Since the launch of the decentralization reform in 2014, the European Union has supported its implementation through a wide range of financial instruments, policy guidance, and technical assistance measures, contributing significantly to the reform's progress and overall effectiveness.

Table 1.

Projects supporting decentralization implemented or planned with EU involvement

Project Name	Regions (*Oblasts*)	Communities (*Hromadas*)	Project Start	Project End	Funding Amount
U-LEAD Programme	All regions	All communities	2016-01-01	2027-12-31	EUR 217 million
Council of Europe Programme	All regions	All communities	2023-01-01	2025-03-31	EUR 1.5 million
DECIDE Project	5 regions	20 hromadas	2020-02-01	2025-05-31	CHF 13.65 million
RFA Project	n/a	n/a	2025-02-21	2031-03-31	n/a
OCORD Project	6 regions	n/a	2022-12-01	2026-11-30	CHF 16.9 million
Polaris Programme	All regions	All communities	2024-06-01	2028-06-01	SEK 250 million
USAID DOBRE Programme	10 regions	60 hromadas	2016-06-08	2025-09-30	USD 107 million
USAID HOVERLA Project	12 regions	74 hromadas	2021-03-19	2027-03-18	USD 150 million
SOERA Project	All regions	All communities	2021-04-26	2028-04-25	USD 100 million
PROSTO Project	All regions	All communities	2021-09-13	2024-01-31	SEK 47 million
SALAR International Programme	All regions	All communities	2014-09-08	2024-01-31	SEK 79.95 million
SURGe Project	7 regions	n/a	2019-10-01	2025-01-31	n/a

Source: https://decentralization.gov.ua/donors

Among the twelve programmes that have been implemented and/or are currently being implemented, the U-LEAD with Europe Programme stands out in terms of both its scale and financial volume. The programme has been implemented with the participation of the European Union, Germany, Poland, Denmark, and Slovenia since 2016 and is scheduled to continue until 2027.

The U-LEAD with Europe Programme aims to strengthen the capacity of local governments and territorial communities through several complementary areas of activity. On the one hand, it supports the implementation of local self-government reform by providing political and legal advice, promoting transparency and integrity in public administration, and contributing to the harmonization of reforms in preparation for Ukraine's accession to the European Union. On the other hand, it offers training and professional advisory support to local communities, with particular attention to the challenges posed by war and post-war reconstruction. Through these activities, the programme enhances the organizational and operational capacities of territorial communities.

In addition, U-LEAD supports local development and digital transformation processes, facilitating the planning and implementation of reconstruction projects and encouraging cooperation between Ukrainian and EU municipalities. These activities also include the development of educational infrastructure, such as the establishment of schools and digital learning centers. Finally, the programme provides direct material assistance to local communities by supporting the restoration of war-affected areas through the provision of construction materials, repair equipment, and means of transport [4].

Another noteworthy initiative is the Council of Europe Programme on Strengthening Local Governance (SLG-COE). Its support activities are structured around three closely interconnected components. First, the programme seeks to improve the legal environment by promoting the alignment of Ukraine's legal framework with European standards, transferring international best practices, and strengthening the legal foundations of decentralization reform. Second, it focuses on improving the quality of public services, particularly in metropolitan areas, by supporting local authorities in delivering services in an efficient and professional manner. Third, the programme aims to strengthen public support for democratic governance by raising citizens' awareness of European norms and standards and increasing societal demand for the enforcement of democratic principles.

The tools used within the Council of Europe Programme include legal expertise and policy advice, capacity-building training, experience-sharing initiatives, study visits, and partnership programmes with Council of Europe member states. These instruments are tailored to Ukraine's current needs and the stage of reform implementation. The integrated approach of the programme contributes to the strengthening of multilevel governance, enhances the institutional capacity of local authorities, and promotes the broader adoption of democratic practices [3].

Beyond direct programme support, the European Union and its institutions have also played an important role in reviewing and evaluating the decentralization reform process. In this context, the Venice Commission has issued several opinions and recommendations during different phases of the reform, providing legal expertise and guidance in line with European constitutional standards [7].

Summary

This study examined the background, development, and outcomes of Ukraine's decentralization reform, with a particular focus on its relationship to the country's European integration process. The research aimed to present the theoretical foundations, historical evolution, and practical effects of the reform. Methodologically, the study was based on a combination of

document analysis and a comprehensive review of the relevant academic and policy literature.

The decentralization reform was launched in 2014 with the objective of fundamentally transforming Ukraine's administrative system and promoting broader social participation in governance. This large-scale reform process has been significantly influenced by external crises, most notably the COVID-19 pandemic and the Russo–Ukrainian war. As a result, even by the time of writing this study (December 2025), the reform cannot be considered fully completed.

Decentralization in Ukraine should not be viewed as a single, isolated measure, but rather as a system of interrelated and mutually reinforcing steps. The Reform Concept adopted in 2014 defined the core principles and directions of the reform, identifying four main priorities: a clear division of powers, a rational territorial structure, improved accessibility of public services, and the establishment of adequate financial conditions.

One of the key outcomes of the reform has been the creation of new local self-government units through the voluntary amalgamation of communities, a process that continues to shape the territorial organization of local governance.

The reform is closely linked to the Copenhagen criteria, particularly with regard to democracy, the rule of law, and transparency. Moreover, financial decentralization plays a crucial role in supporting sustainable economic functioning at the local level. The European Union has been actively involved in supporting this process through a wide range of international programmes, including U-LEAD with Europe and initiatives implemented by the Council of Europe. In addition, the Venice Commission has provided continuous legal review and advisory support throughout the reform process.

In conclusion, the decentralization reform, which has been underway for more than a decade, demonstrates that decentralization in Ukraine is not merely an administrative restructuring. Rather, it represents a profound democratic and political transformation that directly contributes to meeting the conditions for European Union accession.

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TECHNICAL SCIENCES

CONCEPTUAL MODEL OF A GEOGRAPHIC INFORMATION SYSTEM FOR LOCATING LEAKS ON UNDERGROUND TECHNICAL INFRASTRUCTURE – PART SEWERAGE

Kunchev I.,
Associate Professor, Dr., Eng., Faculty of Geodesy
University of Architecture, Civil Engineering and Geodesy
Bulgaria, Sofia 1164, 1 Hristo Smirnenski Blvd.
Borisova S.
Eng., PhD student, Faculty of Geodesy
University of Architecture, Civil Engineering and Geodesy
Bulgaria, Sofia 1164, 1 Hristo Smirnenski Blvd.
https://doi.org/10.5281/zenodo.18070655

Abstract

The management and development of the Water sector in the Republic of Bulgaria are based on two key documents – the "National Strategy for Water Sector Management and Development" and the "Strategy for the Development and Management of Water Supply and Sewerage Systems in the Republic of Bulgaria". These documents identify the main problems related to Sewerage Infrastructure, including insufficient maintenance of Sewerage Systems and facilities. These problems are clearly identified as key issues.

The main objective of this publication is to present the conceptual model of a Geographic Information System for locating leaks in the Sewerage System, with a special focus on the problems related not only to the detection of leaks in the underground technical infrastructure, but also to the structuring of information about the leaks. The conceptual model will be presented through the applicable ISO/TC 211 standards in the field of digital Geographic information and Geomatics, with an emphasis on the application of the principles and approaches of the systems approach.

This model can be a key tool for improving the management of Sewerage Infrastructure as a whole, including reducing losses and increasing efficiency.

Keywords: Sewerage infrastructure, Sewerage system, leaks in underground technical infrastructure, GIS, ISO/TC 211 standards for Geographic information and Geomatics, UML class diagram.

1. Introduction

At the time of this analysis, there are 40 Water Supply and Sewerage operators in the Republic of Bulgaria with different ownership structures (35% are wholly state-owned, 28% are wholly municipal-owned, and 37% are mixed-owned – state and municipal). In certain areas, there are also 28 Water Supply and Sewerage associations, in accordance with the provisions of Article 198b of the Water Act [1].

The lack of regulatory framework governing uniform basic requirements for the creation of a Geographic Information System (GIS) for the needs of Water Supply and Sewerage operators has led to the existence of multiple GIS systems with non-standardized databases, layers, attributes and operations. This hinders the effective management of Sewerage Infrastructure and the development of the sector - [2], sewerage in the country – [3] and [4].

The definition of a Sewerage System is given in § 1, para. 1, item 33 of the transitional provisions of the Water Act [1], namely:: "A set of sewer branches, street sewer networks in urban areas, discharge collectors, and treatment plants or treatment facilities through which wastewater and/or rainwater is drained from consumers properties, their treatment and, where necessary, their disinfection to the required quality and their discharge into the relevant water body."

Based on the analysis of the main documents cited above, it can be concluded that there is a lack of standardized application of: registers of sewerage assets and/or GIS as a technology and approach; registers of treatment plants, sewerage networks, and facilities, including within the meaning of [5] as specialized data and registers; databases/registers for personnel, etc.

One of the main unresolved issues is the collection and use of reliable geographic information about the underground technical infrastructure of the sewerage network, leak detection and their reliable identification in the reference coordinate and elevation system established by national regulations [6]. The purpose of this publication is to present a standardized Metadata level (according to [7]) for locating leaks and damage in the Sewerage network – both visible and hidden in the underground infrastructure.

2. Research methodology

The application of GIS in the field of Sewerage Infrastructure, in this publication, is based on the assumption that: Sewerage is an integral part of the overall technical infrastructure of the country. This should lead to better management/maintenance and reduce the time needed to make adequate management decisions. Structured data according to generally accepted standards [8] will improve the exchange of information between different internal and external users and minimize potential errors.

The data sources used so far by Water Supply and Sewerage operators in the country are diverse, with most of them contained in maps and diagrams on traditional media, as well as in digital files (mainly in AutoCAD DWG and/or ESRI SHP), text documents, etc.

The main problems related to the storage and management of Sewerage Infrastructure data can be summarized as follows:

Much of the information is stored on traditional media (most often paper), which leads to outdated and physically damaged documents;

Different scales of spatial data, which affects the accuracy of location, elevation, and detail. In urban areas, the data is predominantly at a scale of 1:5,000, while in rural areas it is 1:25,000 or 1:100,000;

Lack of information on the sewerage network in some settlements, which hinders response to accidents and investments;

Various digital formats (mainly in AutoCAD DWG, ESRI SHP), but no uniform requirements for the structure and visualization of this data;

Disconnect between asset identifiers and spatial objects (sewer pipes, facilities, etc.), which makes it difficult to keep information up to date;

Lack of standardized procedures for data exchange between departments within water and sewerage operators;

No history of events (leaks, repairs, damage, and interventions) related to sewer system objects and facilities is maintained;

The methodology for data validation is in some cases missing or inadequate.

The creation of a unified GIS for the Sewerage Infrastructure, based on standardized Metadata, would contribute to more efficient management of the latter, as well as faster localization of leaks and accidents.

From what has been said so far, it is clear that the application of GIS as a technology/tool for locating leaks in underground technical infrastructure, with a focus on the Sewerage System, is a complex information system that must take into account all aspects of the technological field.

The conceptual model presented below has been developed in accordance with the approaches and recommendations of ISO/TC 211 of ISO (ISO/TC 211) – Geographic information/Geomatics, [8]. This involves the creation of a reference conceptual model that follows the principles of the systems approach and the application of the principle of synergy.

The methodology presented in this way (implemented through the Meta-meta Data level and the Meta Data level) guarantees reliable results. In addition, it provides opportunities to compare the data obtained with already known results in the subject area under consideration.

Such an approach is essential for the effective management of Sewerage Infrastructure and ensuring data reliability and accuracy.

3. Meta-meta Data Level

The Meta-meta data level of the Sewer System (SS) presented below is in accordance with the guidelines presented in [7] and after the analysis of the studied issues based on the regulatory framework [9] and subjects included in the Water Supply and Sewerage curriculum at the University of Architecture, Civil Engineering and Geodesy (UACEG). The terms and terminology used are in accordance with [10].

In Statistical Classification of Economic Activities in the European Community Rev. 2 (2008): Level 1 Codes – Code E, Water Supply; Sewerage, Waste Management and Remediation Activities, Water Supply is defined as water collection, treatment and supply [11]. These activities cover groundwater, surface water, and rainwater that must be treated, and the supply is delivered to consumers in various sectors—domestic, industrial, or agricultural.

The elements of the SS (in terms of the issues addressed) can be classified into two main categories: Pipe network and Facility. The Pipe network category consists of: Building diversions, Street drains (branches), Collectors, Ducts. The Facility category consists of: Inspection shafts, Rainwater intake shafts (outlets), Waterfall (energy-extinguishing) shafts (belonging to Control and operational subcategory); Rainwater spillways, Holding (regulation) tanks, Sewage pumping stations, Protective channels (belonging to Hydrotechnical and auxiliary subcategory); Wastewater treatment plants, Local treatment facilities, Oil separators, Sludge traps (belonging to Treatment subcategory).

Particular attention should be paid to Sewerage infrastructure, i.e. the perception of Sewerage as an integral part of the overall concept for Spatial Development, including the place, role, significance of [5] and related subordinate legislation (regulations, instructions, and orders), such as [6]. The concept of Sewerage infrastructure is not only a technical one, but also a legal one.

In terms of scope, Sewerage infrastructure refers to pipes and facilities, legal framework, management, planning, investment, maintenance, and everything else related to the modernization of the country's Water Supply and Sewerage Infrastructure.

4. Meta Data Level

The created Meta Data Level (in the form of a UML Class Diagrams) is in accordance with the ISO 19103:2015 Geographic information – Conceptual schema language standard (part of ISO/TC 211 – [8]).

Fig. 1 presents a conceptual model of Sewerage Infrastructure in the context of the current regulatory framework (technical and legal aspects) in the domain of Water Supply and Sewerage and the related domains of Cadastre, Property Register, and Spatial Development.

A UML semantic relationship has been modeled between the classes Sewerage Infrastructure, Cadastre, and Spatial Development, as well as between the classes Cadastre and Property Register, i.e., each class "knows" about the existence of the other (others) and can interact with it (them), with the relationship being bidirectional. The elements of the Cadastre and Spatial Development classes are modeled as UML relationships of the "has a relationship" or "uses" type:

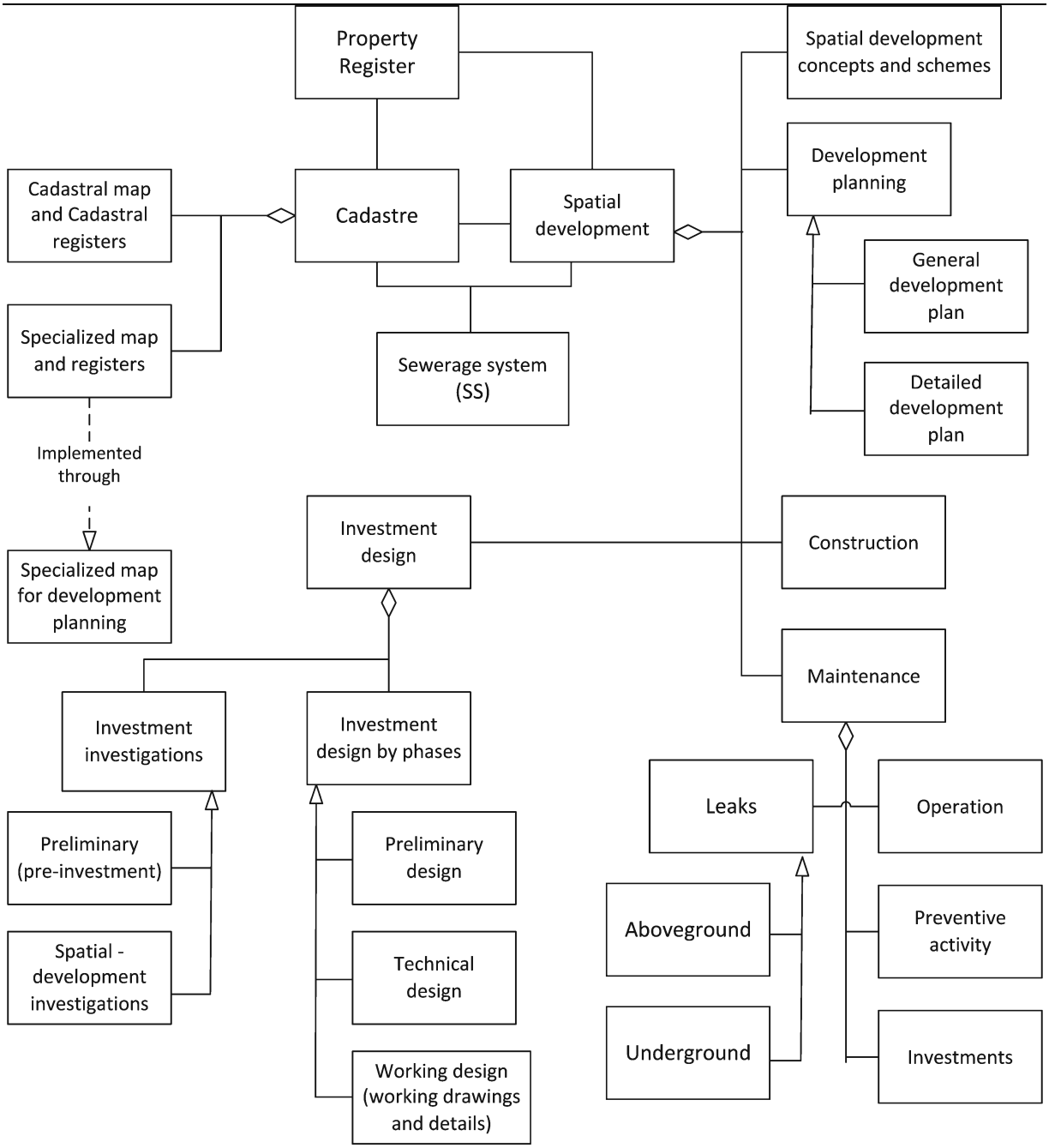

Fig. 1. Conceptual model - Sewerage Infrastructure.

Fig. 2 presents basic categories, subcategory elements, and relations in a sewerage system. UML relationships of the type "has a relationship" or "uses" are modeled:

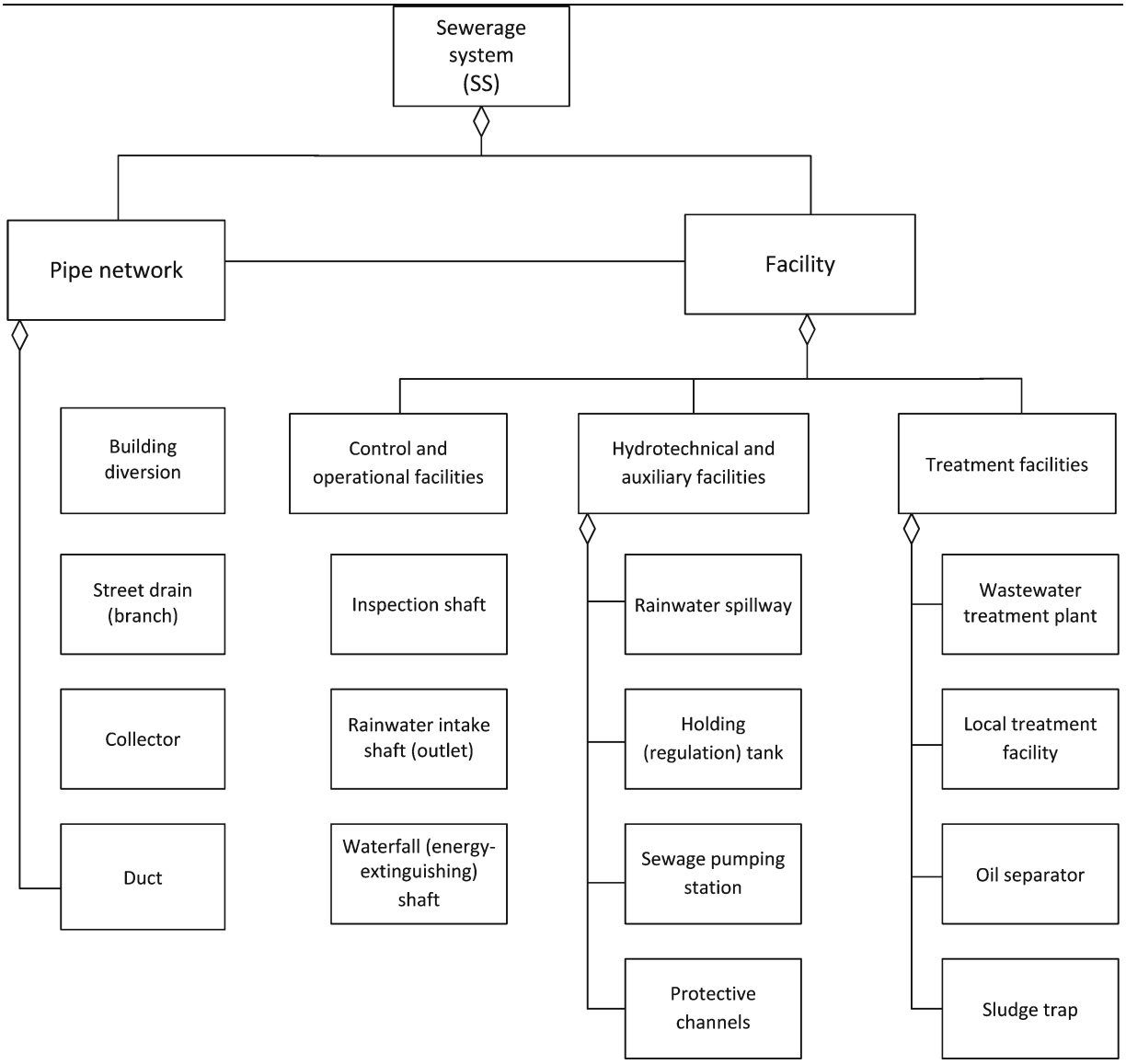

Fig. 2 Basic categories, subcategory elements and relations - Sewerage system (SS).

Fig. 3 presents a high-level diagram of the domain of the sewerage system. The modeling performed reflects the fact that the elements of the SS Metadata Set and SS Dataset classes must be georeferenced in the Reference coordinate/vertical system established in the country – [6]. Leaks in the sewerage system (Leak class) are modeled as a UML relationship of the type "has a relationship" or "uses" with respect to the SS Event class. It is envisaged that the application scheme of the sewerage system will be implemented through the Drawing rule class and applied through the Reference coordinate/vertical system class. To detect and reflect leaks in a Sewerage system, it is planned to apply the currently used approach using SAR images (Synthetic Aperture Radar) – a new, non-invasive and highly effective approach to dealing with leaks and eliminating their adverse effects. For this purpose, a UML relationship of type Specialization has been modeled between the Leak and SAR images classes:

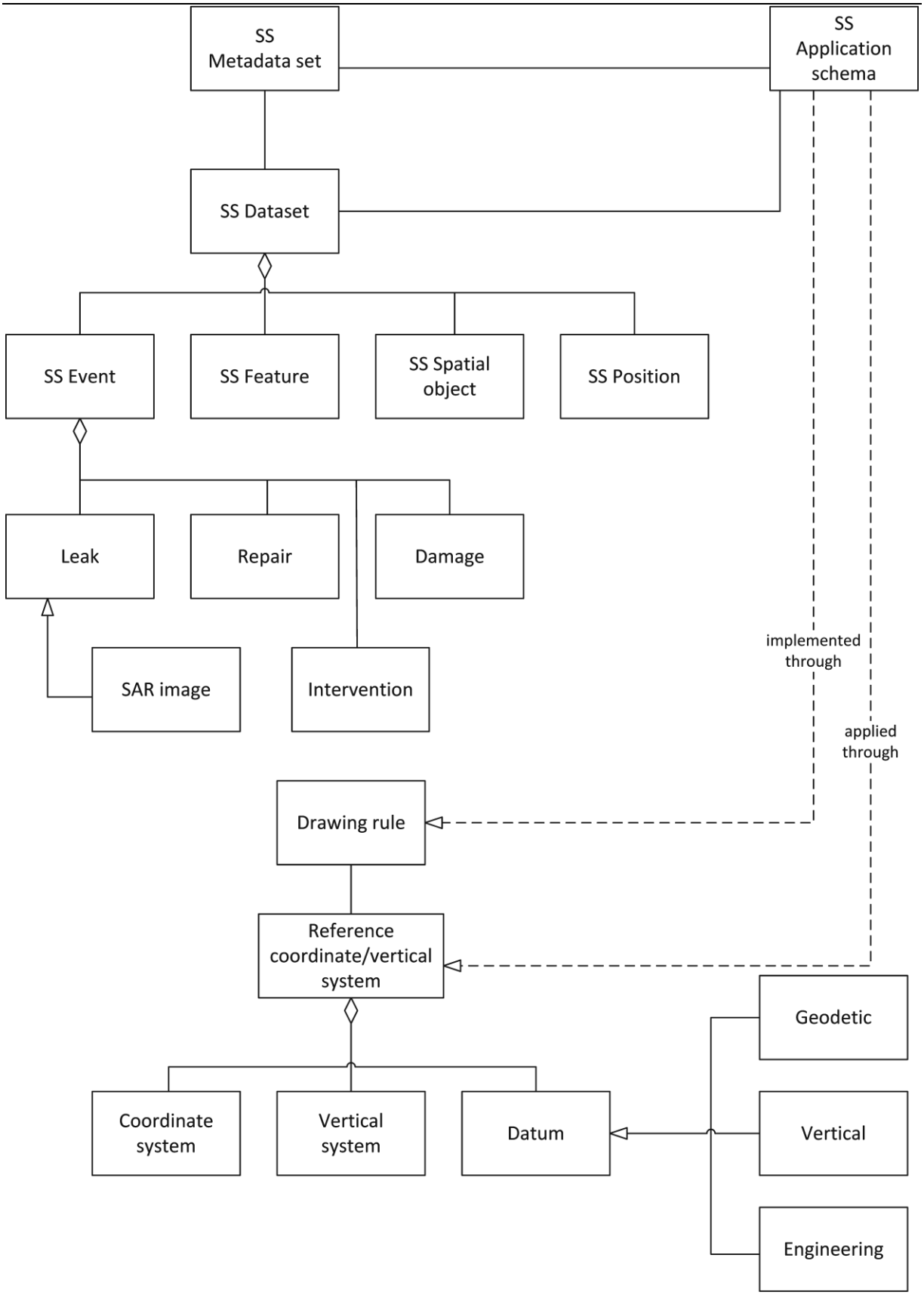

Fig. 3 High level diagram of the domain Sewerage system (SS).

Fig. 4 presents the concept of geometric representation of objects from a Sewerage System through corresponding specializations of the Geometry and Object SS classes. UML semantic relationships between the respective classes are modeled, i.e., each class "knows" about the existence of the other (others) and can interact with it (them), with the relationship being unidirectional (directed):

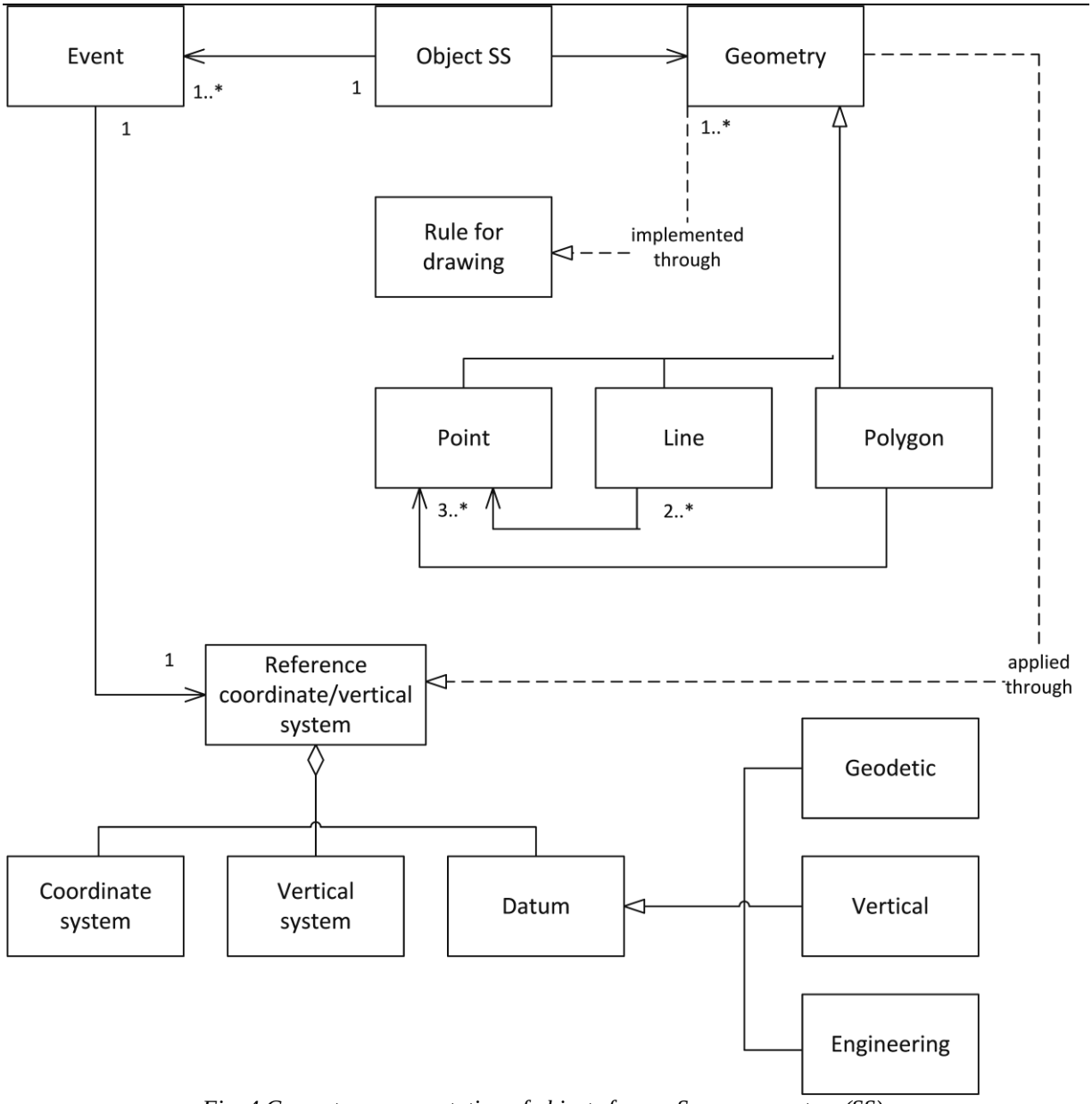

Fig. 4 Geometry representation of objects from a Sewerage system (SS).

5. Conclusion

The presented Meta-meta Data Level and Meta Data Level is in accordance with:

- The principles of the systemic approach that leads to the achievement of synergy and
- The applicable set of generally accepted standards for information on objects or phenomena that are directly or indirectly related to a location relative to the Earth – for this publication these are the standards of ISO/TC 211 Geographic information/Geomatics.

This is a reliable prerequisite for the successful implementation of the next two levels, namely:

- Application schema level (application schemas) - define the types of objects (including attributes and operations), data, and processing;
- Data level - contains the data that is defined by the application schema level.

The inclusion of SAR images in the presented Meta Data Level for detecting and registering leaks in the Sewerage System will expand the functionality of GIS as a technology and reveal the advantages of the approach: non-invasive - does not require excavation or physical access to the network; wide coverage - allows rapid monitoring of large areas (populated areas and/or regional networks); high efficiency – reduced operating costs, complemented by field efficiency – directs resources only to areas with potential problems; detection of leaks that are not visible on the surface; independence from weather conditions.

Acknowledgments

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RESOURCE AND ENERGY SAVINGS IN THE PRODUCTION OF CRUDE BENZENE FROM COKE GAS

Lavrova I.
phD in technical science, Professor
National Technical University «Kharkiv Polytechnic Institute», Kharkiv, Ukraine
https://orcid.org/0000-0002-3970-1627
https://doi.org/10.5281/zenodo.18070657

Abstract

The article discusses the process of removing benzene hydrocarbons from coke gas by absorption with absorbent oils at pressures close to atmospheric pressure. It describes the physical mechanism of absorption based on mass transfer between the gas and liquid phases and the determination of equilibrium concentrations of benzene hydrocarbons according to Henry-Dalton and Raoult's laws. Diagrams of equilibrium concentrations of benzene hydrocarbons in coke oven gas and coal-based absorbent oil at different temperatures are presented, illustrating the effect of temperature and benzene concentration in oil on the efficiency of the process. The optimal operating parameters are determined, in particular, the maximum content of benzene hydrocarbons in the absorbent oil and the permissible temperature of coke oven gas to ensure high extraction efficiency. A set of measures for modernizing the installations has been proposed, including improving gas preparation, oil washing and regeneration, optimizing temperature regimes, and introducing new structural elements of the apparatus and automated control systems. A recommended technological scheme for the absorption of benzene hydrocarbons and the production of crude benzene is presented, which ensures an increase in process efficiency and a reduction in energy costs. The results of the study are of practical importance for improving coke gas purification technologies at coke chemical plants.

Keywords: process intensification, benzene hydrocarbons, coke gas, absorption, mass transfer, distillation column, hydrodynamic parameters, modernization, coal tar oil, scrubber, regular contact devices, gas purification, coke chemical production, efficiency, operating parameters, energy saving

Benzene hydrocarbons are found in coke oven gas in the form of vapors, and they can be extracted using various methods. However, absorption using absorbent oils at a pressure close to atmospheric pressure is the method most commonly used worldwide. Desorption of benzene hydrocarbons from saturated oil is carried out by blowing a large or small amount of hot steam through preheated oil.

The absorption of benzene hydrocarbons by absorbent oil is a physical process in which mutual mass transfer occurs between the gas and liquid phases in the direction of equilibrium. The state of equilibrium is determined by Henry-Dalton and Raoult's laws [1]. According to these laws, at a constant temperature, the concentration of crude benzene in the absorbent oil is proportional to the partial pressure of benzene in the gas phase. Since equilibrium concentrations are never achieved in the equipment used for the absorption process, they are usually considered as the limit towards which the process tends under specific technological conditions (temperature, pressure, quality characteristics of the absorbent oil, etc.) [2, 3].

Fig. 1 shows diagrams of equilibrium concentrations of benzene hydrocarbons in coke gas and coal tar absorption oil at different contact temperatures. These diagrams are calculated for coal tar oil with a molecular weight of M = 150. According to these diagrams, if the absorbent oil supplied to the scrubbers contains only 1% of benzene hydrocarbons, the equilibrium concentration of the latter in coke oven gas will be: at 25°C – 9 g/m^3; at 35°C – 12 g/m^3; at 40°C – 16 g/m^3. If oil containing 2 g/m^3 of benzene hydrocarbons is supplied to irrigate the scrubbers, the equilibrium concentration at 40°C will be 32 g/m^3. Such absorbent oil will remove practically nothing from coke gas with a normal benzene hydrocarbon content of 33 – 36 g/m^3. In order to ensure that the residual content of benzene hydrocarbons in the purified gas is reduced to 3 g/m^3. The Rules for Technical Operation of Coke Chemical Plants establish the following parameters:

– the absorbent oil used for extraction must contain no more than 0.3% of benzene hydrocarbons (in practice, in countries that are leaders in coke chemical production, these values are 0.1 – 0.2%);

– the average temperature of coke oven gas should not exceed 30°C (in some practice, the value of 25-28°C is more often indicated);

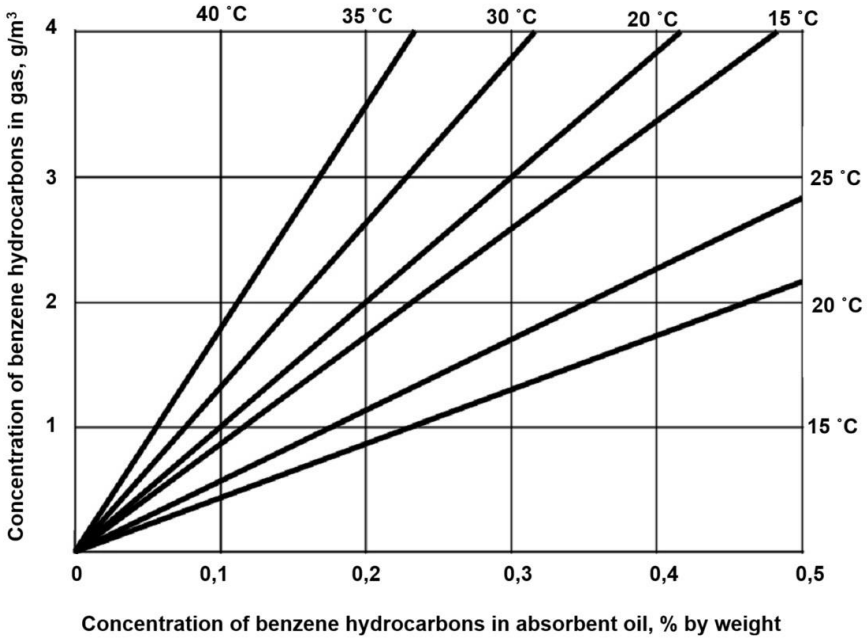


Figure 1. Diagrams of equilibrium concentrations of benzene hydrocarbons in coke gas and coal tar absorbent oil at different contact temperatures

It should be emphasized that compliance with the specified technological parameters is mandatory for all devices for the absorption of benzene hydrocarbons (regardless of the packing, injectors, plates, etc. used), as these parameters are decisive [4, 5]. The technological schemes used, equipment design, and other factors are secondary, ultimately ensuring the economics of the process.

Most coke chemical enterprises in Ukraine are characterized by increased losses of benzene hydrocarbons with reverse gas, which exceed the maximum permissible limits specified above [6]. This situation is the cumulative effect of a number of negative factors, which primarily include:

- instability of gas and absorbent oil consumption;
- unsatisfactory temperature conditions;
- low quality of recycled absorbent oil;
- unsatisfactory condition of main technological equipment;
- low availability of control and measuring devices in installations.

Many coke chemical plants are working to modernize their facilities and technological equipment and adapt them to modern technological conditions.

When modernizing existing plants and constructing new ones, the above technological parameters must be maintained and the measures and technical solutions implemented in industrial practice by advanced plants in foreign countries and Ukraine must be taken into account [7]. The main improvements include the following:

1. Better preparation of coke oven gas supplied for the removal of benzene hydrocarbons from acidic components (HCN, H_2S), naphthalene, and unsaturated compounds. One option for solving this problem is to install scrubbers for the removal of benzene hydrocarbons after desulphurization. This will significantly increase the service life of coal absorption oil while increasing the depth of benzene hydrocarbon removal.

2. Washing the working absorbent oil with water to reduce its corrosive activity by washing out aggressive components. It has been established that a 60 – 70% reduction in the content of NH_4CNS, $(NH_4)_2S$, NH_4CN reduces the corrosive activity of the oil by 4 – 6 times. It is recommended to flush part of the working oil taken from circulation. Savings are achieved primarily by increasing the service life of the oil and, naturally, the service life of the main technological equipment.

3. Stabilization of the quality of working coal tar absorbent oil by regenerating part of it in order to remove the polymers formed and minimize the amount of refractory components (anthracene, carbazole, etc.) remaining in the latter.

4. Replenishment of the cycle with fresh coal absorption oil that meets the requirements of modern technical specifications for oil grade “A” or its imported analogues, which are sometimes found in the practice of coke chemical production in Ukraine.

5. Optimization of the gas and oil temperature range by differentiated supply of benzene-free absorption oil according to the stages of absorption. This technique allows reducing the content of benzene hydrocarbons in the return gas by significantly lowering the temperature of the oil supplied to the last stage of absorption without its dehydration. The essence of the proposal is to compensate for oil heat loss by adding small amounts of hot benzene-free oil to the main flow of the latter. Industrial research has shown that the proposed technological scheme allows reducing the loss of benzene hydrocarbons with the return gas by an average of 2 – 5 g/m^3 compared to the traditional scheme. The temperature of the oil supplied to the last stage (along the gas flow) is reduced by an average of 7 – 8°C.

6. Use of scrubbers with regular packing elements that combine high throughput with increased efficiency at the stage of absorption of benzene hydrocarbons from coke gas.

7. When designing new equipment, use new highly efficient internal structure elements (packing, gas and oil distributors and redistributors) that ensure the necessary process efficiency in a single piece of equipment.

8. A clearer separation of crude benzene and coal tar oil in the distillation column is recommended to be achieved by increasing the number of plates and performing deflegmation using reflux. At the same time, it should be possible to remove naphthalene from the recycled oil.

9. Increasing the number of plates in the distillation column is advisable not only from the point of view of stabilizing the quality of the absorbent oil, but also because of the possibility of reducing its consumption, as well as a significant reduction in the consumption of sharp steam for desorption. Reducing the steam supply to the column leads to a decrease in the required deflegmation surface, a reduction in the consumption of technical water for steam cooling, and a decrease in the amount of wastewater.

10. For the final heating (to 170-180°C) of saturated coal oil before feeding it into the distillation column, it is recommended to use tubular furnaces with flameless panel burners.

11. Use of high-efficiency heat exchange equipment, which allows the process of heat exchange, deflegmation, and condensation of the target product to be carried out with minimal energy losses. In particular, the use of spiral heat exchangers capable of operating effectively in environments containing solid inclusions can significantly increase heat transfer coefficients. There are examples of the successful use of these devices at a number of coke chemical plants in our country.

12. Development and implementation of automated control systems for the absorption of benzene hydrocarbons from coke oven gas and the desorption of crude benzene from absorbent oil. Despite the very significant costs of using real-time control and measurement equipment, this is economically advantageous. Estimated reductions in energy and material costs can reach 12 – 15%; there are reductions in the volume of fresh water supplied to cooling towers, as well as a reduction in wastewater volumes.

13. Use of frequency control of electric drives for energy saving and more accurate control of process parameters.

All of the above improvements cannot always be applied simultaneously, as they are partially mutually exclusive. However, when combined rationally, they can significantly reduce production and energy costs for crude benzene production. As an option for such a solution, the technological scheme for the absorption of benzene hydrocarbons and the production of crude benzene, shown in Fig. 2, can be considered.

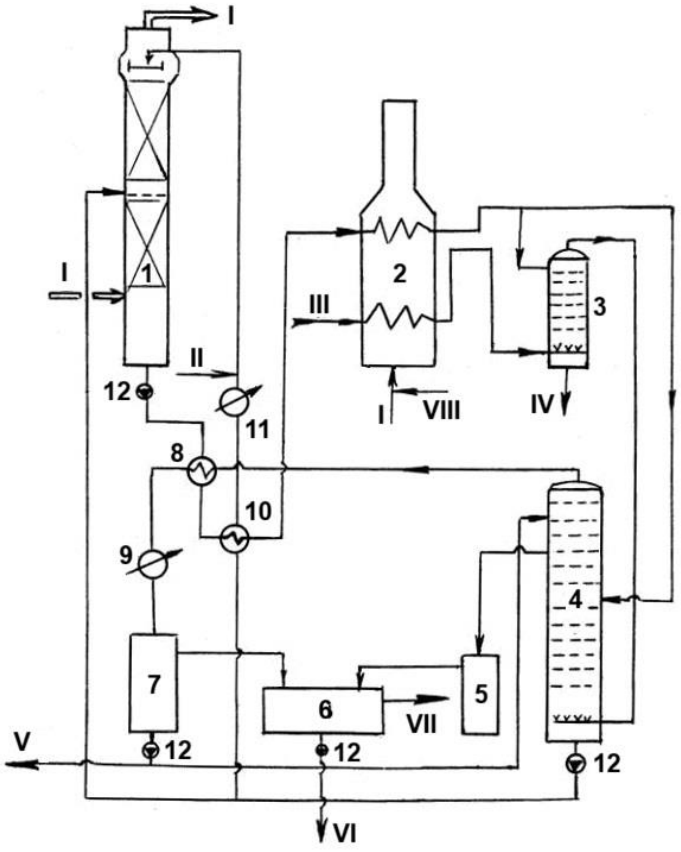


Figure 2. Recommended scheme for the absorption of benzene hydrocarbons from coke gas and the production of crude benzene.

1 – scrubber; 2 – tube furnace; 3 – regeneration column; 4 – distillation column; 5 – separator; 6 – naphthalene settler; 7 – separator; 8 – heat exchanger; 9 – condenser; 10 – oil-oil heat exchanger; 11 – refrigerator. Material flows: I – coke gas, II – fresh oil, III – steam, IV – polymers, V – crude benzene, VI – water from separator, VII – naphthalene.

The recommended process flow diagram works as follows: coke oven gas stream I with a temperature of 25 – 28°C enters the lower part of scrubber 1, is distributed across its cross-section, and interacts on the surface of the regular packing with benzene-free absorption oil, which is distributed in the upper part and leaves the apparatus.

In turn, the saturated absorbent oil is pumped through heat exchangers 8, 10 to a tubular furnace 2, where it is heated to a temperature of 170 – 180°C. The vapors and heavy fractions of the latter are fed further to the feed plate of the stripping section of the benzene column 4. Flowing down the plates of the stripping section of the benzene column, the oil comes into contact with the rising vapor phase, which consists of water vapor, benzene hydrocarbon vapors, and absorbent oil.

As a result, the upward-moving vapor phase is enriched with volatile components, and the downward-moving liquid phase is enriched with absorbent oil components. To create an upward flow of the vapor phase in the exhausting part of the distillation column, part of the oil after the tubular furnace is fed into the upper part of the regeneration column 3, and steam III, superheated in the tubular furnace 2, is fed into the lower part of the same column. As a result, light oil fractions are distilled into distillation column 4 and the bottom residue ("polymers") IV is subsequently removed.

Oil vapors containing benzene hydrocarbons, as well as water vapors from the exhaust section; enter the strengthening section of distillation column 4, to the top tray of which raw benzene is fed as reflux. Flowing downwards towards the oil vapor stream, the reflux evaporates completely due to the heat of the upward flow of crude benzene and water, as well as the heat of condensation of the oil vapors, which are almost completely returned to the stripping section of the column.

In turn, benzene hydrocarbon vapors are removed from the top of the strengthening section by condenser 8 and cooler 9 for complete condensation. The condensate of water vapor and benzene hydrocarbons is sent to separator 7 to separate crude benzene from water. Part of the crude benzene from the separator 7 assembly is fed by a pump as reflux to the distillation column, and the other part is removed from the cycle as a finished product (crude benzene) V.

In the strengthening part of the column, there is a certain gradient of temperature and composition of the liquid phase along the height of the column. The upper trays of the strengthening section contain mainly lower-boiling components (crude benzene) in the liquid phase. The lower trays contain mainly higher-boiling components (absorbent oil) in the liquid phase. An intermediate fraction enriched with naphthalene is selected from the middle part, separator 5. This makes it possible to actually reduce the naphthalene content in the return oil.

The main advantages of the proposed technological schemes, supported by modern technological equipment, include:

- stabilization of the quantitative composition of the obtained crude benzene (with distillation fluctuations up to 180°C not exceeding ±1% in the range from 91 to 96%);
- reduction of gas pressure losses during absorption in the scrubber, which is recommended to be 30 – 50% compared to those currently used;
- reduction of steam consumption for distillation of absorbent oil by 2 – 2.5 times compared to that currently used;
- reduction in the amount of wastewater from the benzene section subject to disposal
- reduction in material and energy consumption in the development of modern absorbers with regular packing.

In recent years, there has been considerable and well-founded practical interest in scrubbers with regular packing elements, due to their high gas phase throughput capacity, large specific phase contact surface area, and low hydraulic resistance [8, 9]. That is why these devices are now used in industrial practice in coke and petrochemical production for the capture of benzene hydrocarbons, hydrogen sulfide, final cooling of coke oven gas, and others.

At the same time, the practice of operating industrial devices with regular metal packing has shown that their efficiency is often significantly lower than in tests under experimental and industrial conditions [10]. This is due to a number of reasons, the most important of which is the significantly greater complexity of the absorbent distribution than in the basic version. And even if a relatively uniform initial distribution of the absorbent is achieved, it is not always possible to maintain it throughout the height of the apparatus due to local contamination, corrosion, and technological factors affecting surface tension, wettability.

There are currently two realistic approaches to mitigating the impact of this extremely negative phenomenon, namely:

1. The most common approach, recommended by the theory of "large-scale transitions" and associated with sectioning the apparatus vertically using devices for redistributing interacting phases;

2. An approach associated with the use of packing that are capable of redistributing interacting gas (vapor) and liquid due to their design features.

The first approach has gained some popularity and is being developed through the improvement of devices for redistributing interacting phases, which have a number of complex (and sometimes contradictory) criteria, primarily including:

- even distribution of irrigation fluid across the surface of packing elements;
- minimal splashing;
- reliability in operation;
- minimal pressure loss in the distributor installation area;
- minimal energy consumption for irrigation fluid distribution;
- simplicity of devices, their manufacture, and installation;
- stable operation over a wide range of loads.

Despite the large number of different designs of these devices and the large volume of experimental and

theoretical research summarized in a series of monographs, this issue is far from being resolved.

With regard to regular packing devices, various packing-type designs have become widely used, in which the upper layer of the nozzle is completely wetted due to the fine spraying of the irrigation liquid. However, in countercurrent conditions, even in outdated "slow-speed" devices with wooden chord packing and low gas velocities, significant splash carryover was observed, which is highly undesirable.

In the operating conditions of intensive devices with regular sheet packing, where the average gas velocities are 3 – 3.5 m/s, splash carryover can reach significantly higher values. Therefore, effective splash guards must be installed to localize it [11, 12].

Coke chemical plants currently use units with regular metal packing. These are units with scrubbers with Z-shaped packing and packing distribution of absorbent oil. A characteristic feature of these scrubbers is the use of shortened flat-parallel packs as support grids under the packing and for redistributing the absorption oil. Or installations with scrubbers with flat-parallel packing, disc distribution, and intermediate redistribution of absorbent oil along the height of the apparatus. A specially designed perforated plate placed in an expansion chamber is used as a device for the primary distribution of absorbent oil, and vortex plates, similar for different scrubbers, are used as intermediate redistributors. Let us conditionally refer to these installations as option 1.

Subsequently, coke chemical plants in Ukraine began to use scrubbers with a flat-parallel packing and new disc devices for the distribution and redistribution of gas and absorbent oil [13].

Low-pressure sprayers evenly distributed in the space under the plate are used as devices for spraying the absorbent oil redistributed by the plate. To enhance the mass transfer effect, the developers envisaged mixing the absorbent oil on the plate using the energy of the gas flow (option 2). In real production conditions, with the characteristic low quality of recycled absorbent oil containing a large amount of solid inclusions, the devices quickly became clogged. In particular, with a coke oven gas consumption of about 65 thousand m^3/hour and a specific consumption of coal absorption oil of 2.2 – 2.3 l/m^3 of gas, the resistance of one scrubber reached values of about 4 kPa. Moreover, the main increase in resistance occurred in the upper distribution plate and the upper tier of the packing, as well as in the lower tier of the packing and the primary gas distributor.

All of the above-mentioned benzene plants were initially designed for a gas throughput capacity of about 100000 m^3/hour. All plants had the same amount of packing material placed in two sequentially connected scrubbers with a diameter of 3.6 m.

The actual performance indicators of the technical installations discussed above with different internal structural elements are shown in Table 1, which shows that technical installations with a flat-parallel packing in the first variant have higher performance and efficiency indicators for the removal of benzene hydrocarbons with acceptable pressure losses. Installations with Z-shaped packing and injector distribution of the absorber are slightly inferior in terms of extraction efficiency and total pressure losses.

Both of these options have significant advantages over the second option with a flat-parallel packing in terms of both the efficiency of benzene hydrocarbon extraction and the overall performance of the unit [14].

One of the main reasons for the lower efficiency of installations with scrubbers with Z-shaped packing is the insufficiently reliable operation of the primary oil distributors and the absence of oil redistributors along the height of the devices.

Even well-designed modern injectors in the optimal spray mode of absorbent oil have a high degree of uneven distribution across the cross-section of the apparatus.

When fluid flow fluctuates, this value increases. It is necessary to note another extremely negative fact characteristic of injector distribution of absorbent oil – increased spray carryover, which increases as the gas velocity increases. To localize it in scrubbers with a Z-shaped packing, two splash guards (louver and cyclone) are installed, made together with the shell body.

These splash guards, as will be shown below, are the main cause of increased pressure losses. When using correctly selected disc distributors, the uniformity of absorbent oil distribution is practically independent of the flow rate over a wide range of liquid loads.

Table 1.

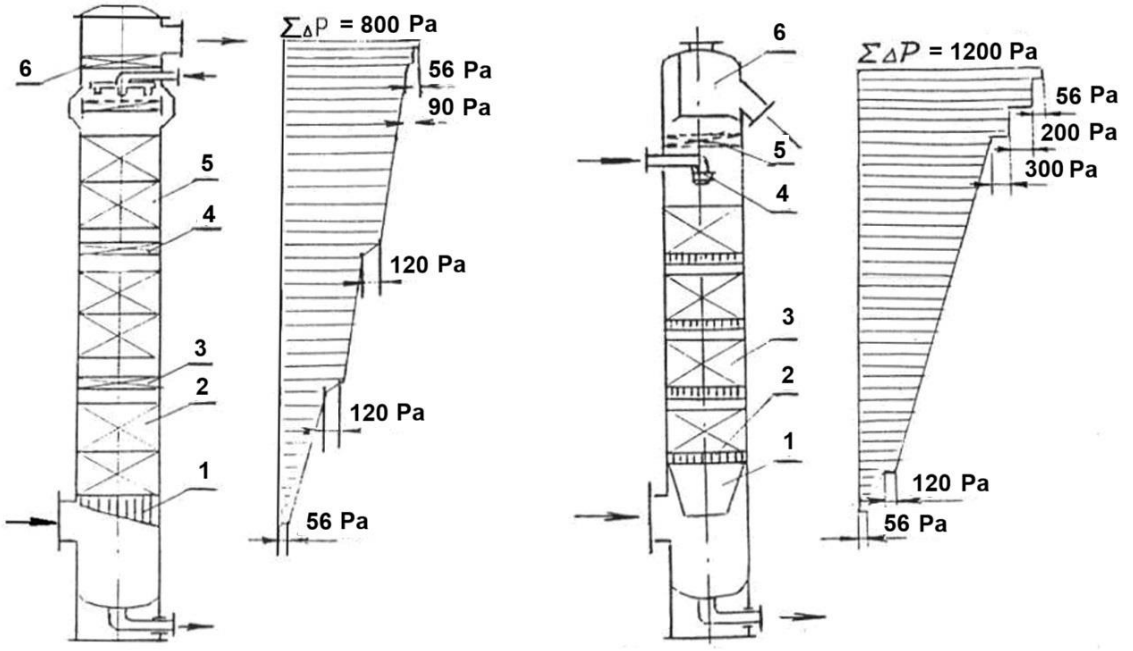
Key performance indicators for comparable technological installations

Indicators	Scrubber installations		
	with flat parallel packing		with Z-shaped packing
	option 1	option 2	
Gas throughput capacity (actual), thousand m^3/hour	100 – 110	50 – 70	80 – 90
Consumption of coal-based absorbent oil, m^3/hour	170 – 180	150 – 160	150 – 160
Oil temperature, °C	30	30	30
Residual content of benzene hydrocarbons in purified gas, g/m^3	3	5 – 6	4.5
Pressure loss in one scrubber, kPa	0.8 – 1	1.7 – 4*	1.2 – 1.4

* The maximum values are obtained when filling in the elements specified in the text.

When installing a disc distributor in an expansion chamber, where gas bypasses the disc along the periphery, pressure losses at the installation site are minimized.

To determine the reasons for the significant difference in resistance between installations with a flat-parallel packing (option 1) and a Z-shaped packing, we constructed head loss diagrams calculated according to the corresponding dependencies and measured during commissioning (Fig. 3).



a

1 – gas distributor; 2.5 – flat parallel packing blocks; 3.4 – redistribution plates; 6 – splash guard; 7 – distribution plate

b

1 – conical gas distributor; 2 – support grate; 3 – Z-shaped packing block; 4 – injector; 5 – splash guard; 6 – cyclone splash guard

Figure 3 – Head loss diagrams in scrubbers with regular sheet packing (a – flat-parallel; b – Z-shaped)

The data presented shows that both the overall resistance of the installations and the resistance of individual scrubbers is determined by pressure losses in auxiliary elements. Thus, for comparable scrubbers with a flat parallel packing, with a total resistance of one device of about 800 Pa, the pressure losses in the packing are only 360–380 Pa. For scrubbers with a Z-shaped packing with a total resistance of 1200 Pa, the pressure loss in the packing is only 470–490 Pa. Obviously, the use of less energy-intensive auxiliary devices will reduce the total pressure loss in the installation as a whole.

In particular, the use of a device with an expansion chamber for the primary distribution of absorbent oil in scrubbers with a Z-shaped packing will significantly reduce pressure losses (by 500–560 Pa). In turn, for scrubbers with a flat-parallel packing, it is advisable to reduce the number of redistribution devices and replace them with less energy-intensive ones. In particular, redistribution units similar to those used in scrubbers with a Z-shaped packing may be of interest as devices for redistributing absorbent oil.

Even greater opportunities for significantly reducing the energy consumption of comparable technological installations are provided by the transition to placing the required packing surface in a single device by reducing the number of gas inlet and outlet devices. In particular, for installations with a flat-parallel packing, it is possible to reduce pressure losses by 40%, and for installations with a Z-shaped packing, by 30%.

However, it should be emphasized that the use of known packing (flat-parallel, Z-shaped) for these purposes will result in excessively tall devices (H = 50 m). This, in turn, will complicate their transportation from manufacturing plants and routine maintenance (repair, painting). It is also necessary to note the increase in the cost of transporting the absorber to the top of the apparatus.

Therefore, for the practical implementation of the above-proposed areas of intensification, it is necessary to use packing elements that combine the increased throughput and low hydraulic head losses characteristic of flat-parallel and Z-shaped packing with increased efficiency.

Our research has shown that to solve the technical problem of achieving a 90–95% extraction rate of benzene hydrocarbons in a single technological apparatus, volumetric packing that eliminate a number of disadvantages inherent in various versions of flat parallel and Z-shaped packing may be of practical interest [15].

One such device is a cellular comb (honeycomb) packing (Fig. 4).

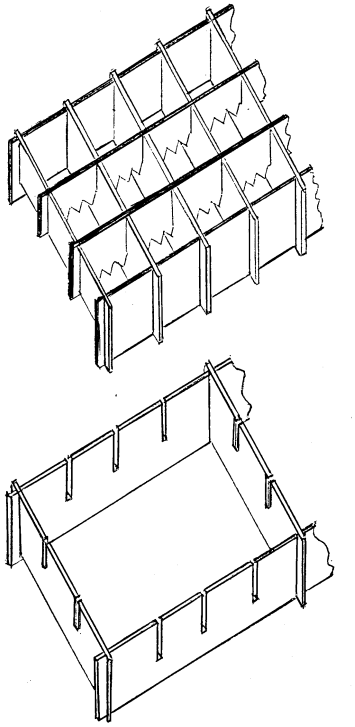


Figure 4. Element of a regular cellular comb (honeycomb) packing.

As a result of developing the cellular comb (honeycomb) packing, the range of working gas speeds has been increased to 4 – 5 m/s under conditions of low pressure loss (up to 80 – 100 Pa per 1 m of height), and it also stands out from its counterparts due to its simplicity of manufacture.

The cellular comb (honeycomb) packing has vertical square channels formed by a series of strips of sheet material installed on edge and arranged parallel to each other; they have grooves with a constant pitch on the upper edge, into which strips of sheet material are inserted. These design features allow:

1. Create a regular package that combines low metal consumption with strength.

2. Significantly simplify (and, as a result, make cheaper) the packing manufacturing process, use materials in the manufacture of the latter that cannot be used to manufacture Strepak-type packing (alloyed cast iron, some composite materials).

3. Eliminate the need for special equipment for making regular packing, which is used for cutting slots and subsequent stretching.

4. Significantly reduce the likelihood of clogging of regular packing with mechanical impurities present in technical fluids.

5. Significantly increase the turbulence of the contacting gas and liquid and the frequency of surface renewal of regular packing.

The design is explained in Fig. 4, which shows a regular cellular comb (honeycomb) packing insert consisting of strips of sheet material with grooves made at regular intervals on the upper edge of each strip, the width of which is approximately equal to the thickness of the strips. During installation, these strips are placed at regular intervals on the edge so that the grooves on each of the strips are on the same generatrix. Other strips are inserted into these grooves, which may have saw-like drip edges at the bottom, including those spread in different directions.

Conclusions

Resource- and energy-saving technological schemes for the absorption of benzene hydrocarbons from coke gas and the production of crude benzene are based on the rational combination of an optimally selected technological regime and the use of intensive scrubbers equipped with modern high-efficiency internal structure elements (regular packing, distributors and redistributors of interacting phases).

There is a real possibility of organizing the absorption process in a single high-capacity technical apparatus, which reduces the resistance of the installation by 35 – 40% and creates the conditions for the complete automation of the process of extracting benzene hydrocarbons from coke gas.

The proposed technical solutions can be used both in the design of new benzene departments and in the reconstruction of existing enterprises.

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